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ATLAS OF HUMAN ANATOMY

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HUMAN ANATOMY

BY DR. JOHANNES SOBOTTA
PROFESSOR OF ANATOMY AND DIRECTOR OF THE ANATOMICAL INSTITUTE IN BONN

EDITED FROM THE SIXTH GERMAN EDITION BY

J. PLAYFAIR McMURRICH
PROFESSOR OF ANATOMY IN THE UNIVERSITY OF TORONTO

VOLUME I

THE BONES, LIGAMENTS, JOINTS, REGIONS AND MUSCLES OF THE HUMAN BODY

VOLUME II

THE VISCERA INCLUDING THE HEART

VOLUME III

THE NERVOUS AND BLOOD VASCULAR SYSTEMS AND THE SENSE ORGANS OF THE HUMAN BODY

G. E. STECHERT & CO., NEW YORK 1928

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VOLUME II

THE VISCERA INCLUDING THE HEART

WITH 101 COLORED AND 98 UNCOLORED FIGURES, TOGETHER WITH 40 PARTLY COLORED TEXT-FIGURES, FROM ORIGINAL DRAWINGS BY K. HAJEK

G. E. STECHERT & CO., NEW YORK 1928

UNIVERSITY
COLLEGE
LONDON

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[1]) The rest of the Angiology is contained in Volume III.

Explanation

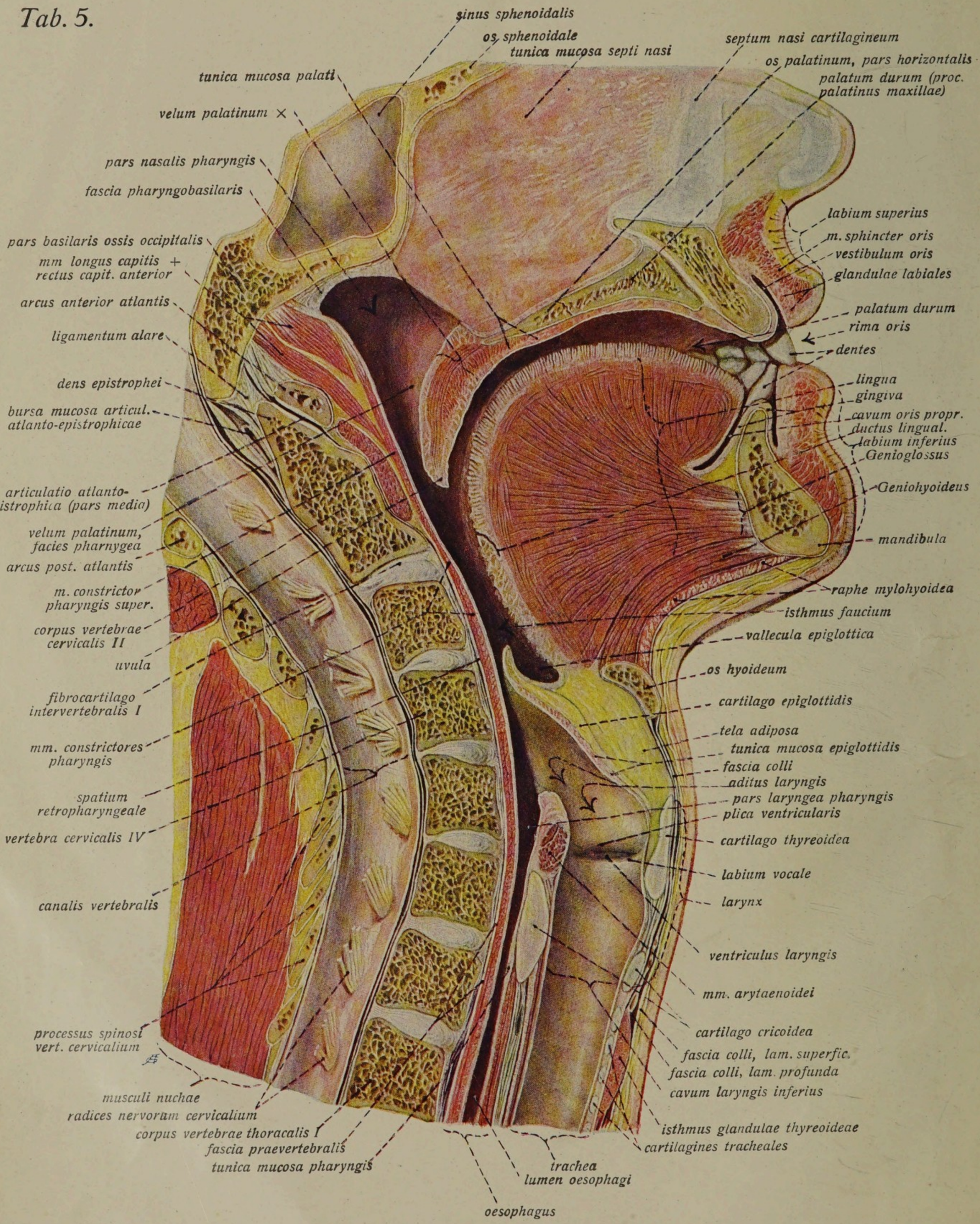
of the abbreviations used in the illustrations of this Volume.

a. or art. = arteria
ant. = anterior or anterius
cart. = cartilago
duct. = ductus
ext. = externus, — na, — num
inc. = incisura
inf. = inferior, — ius
int. = internus, — na, — num
later. = lateralis, — le
lig. = ligamentum
m. = musculus
mm. = musculi
med. = medialis, — le
n. = nervus
nn. = nervi
post. = posterior, — ius
sup. = superior, — ius
v. or ven. = vena, venae

$\times$ denotes that the part so marked is cut through or cut away.

As a rule m. or musculus is omitted and that the structure is a muscle is indicated by its name being spelled with a capital initial letter.

Tab. 5.


sinus sphenoidalis
os sphenoidale
tunica mucosa septi nasi
septum nasi cartilagineum
os palatinum, pars horizontalis
palatum durum (proc. palatinus maxillae)
tunica mucosa palati
velum palatinum
pars nasalis pharyngis
fascia pharyngobasilaris
pars basilaris ossis occipitalis
mm longus capitis + rectus capit. anterior
arcus anterior atlantis
ligamentum alare
dens epistrophei
bursa mucosa articul. atlanto-epistrophicae
articulatio atlanto-epistrophica (pars media)
velum palatinum, facies pharnygea
arcus post. atlantis
m. constrictor pharyngis super.
corpus vertebrae cervicalis II
uvula
fibrocartilago intervertebralis I
mm. constrictores pharyngis
spatium retropharyngeale
vertebra cervicalis IV
canalis vertebralis
processus spinosi vert. cervicalium
musculi nuchae
radices nervorum cervicalium
corpus vertebrae thoracalis I
fascia praevertebralis
tunica mucosa pharyngis
labium superius
m. sphincter oris
vestibulum oris
glandulae labiales
palatum durum
rima oris
dentes
lingua
gingiva
cavum oris propr.
ductus lingual.
labium inferius
Genioglossus
Geniohyoideus
mandibula
raphe mylohyoidea
isthmus faucium
vallecula epiglottica
os hyoideum
cartilago epiglottidis
tela adiposa
tunica mucosa epiglottidis
fascia colli
aditus laryngis
pars laryngea pharyngis
plica ventricularis
cartilago thyreoidea
labium vocale
larynx
ventriculus laryngis
mm. arytaenoidei
cartilago cricoidea
fascia colli, lam. superfic.
fascia colli, lam. profunda
cavum laryngis inferius
isthmus glandulae thyreoideae
cartilagines tracheales
trachea
lumen oesophagi
oesophagus

Splanchnology.

Plate 5. Median section of the head and neck.

Fig. 327.

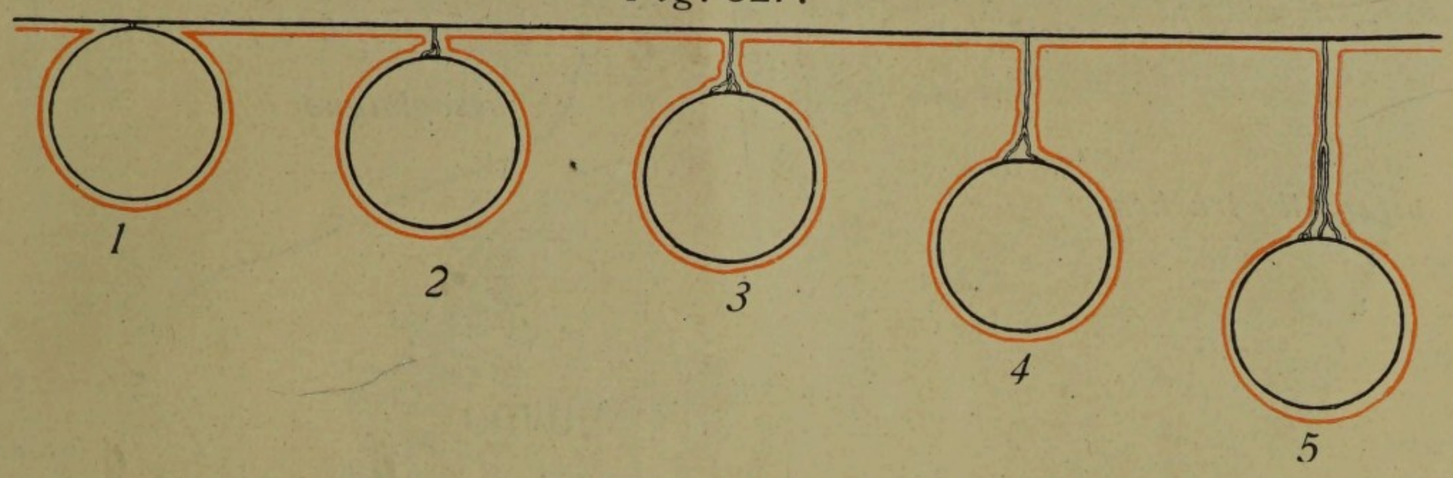


Fig. 327. Schema of the relations of the intestines to the peritoneum (black). 1. an intestine that rests on the posterior abdominal wall; 2—5 intestines at a greater or less distance from the body wall.

The posterior abdominal wall is indicated by a red line, the vessels to the intestines are wavy red lines.

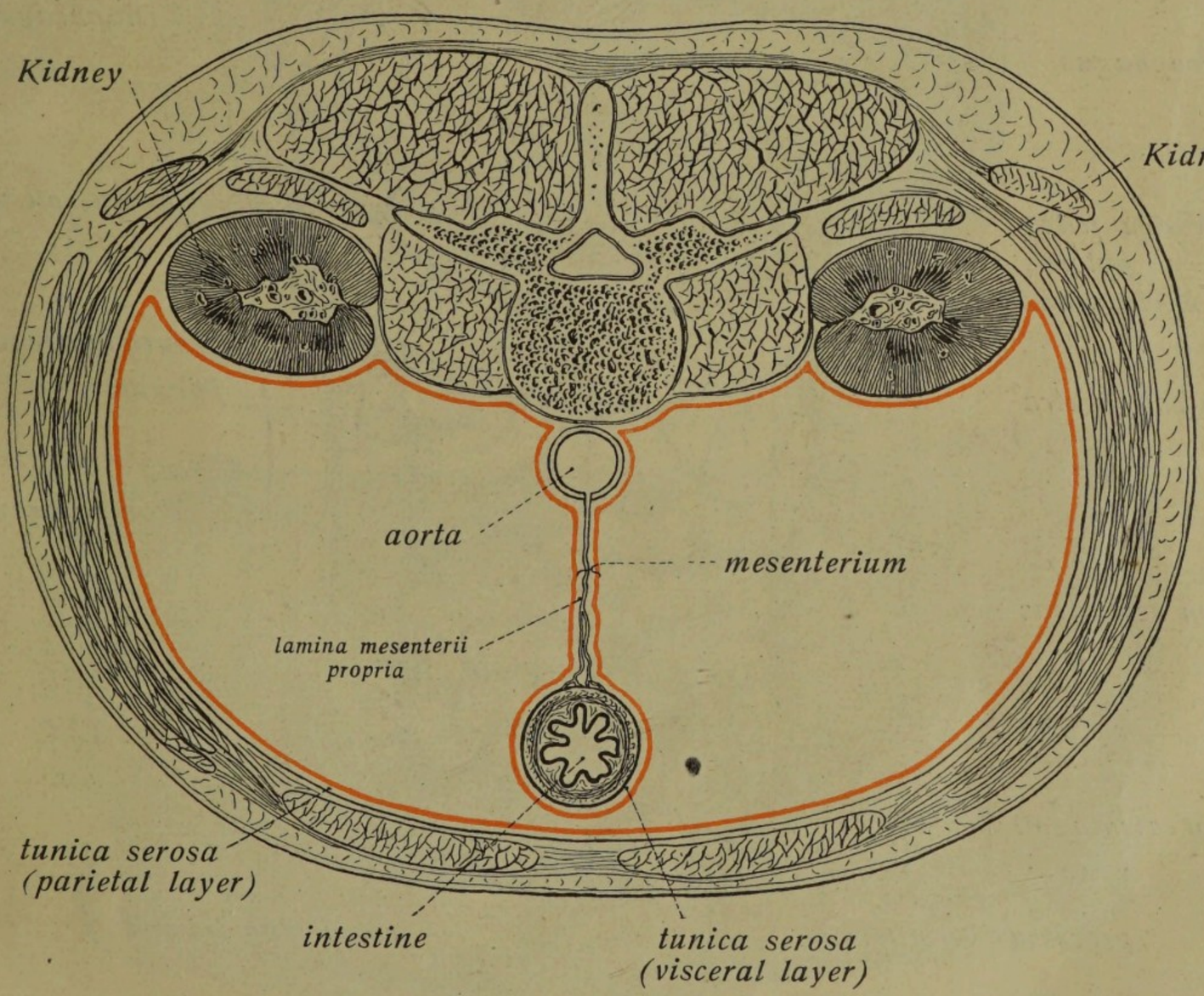


Fig. 328.

Schema of the peritoneal cavity, the serous membrane is red.

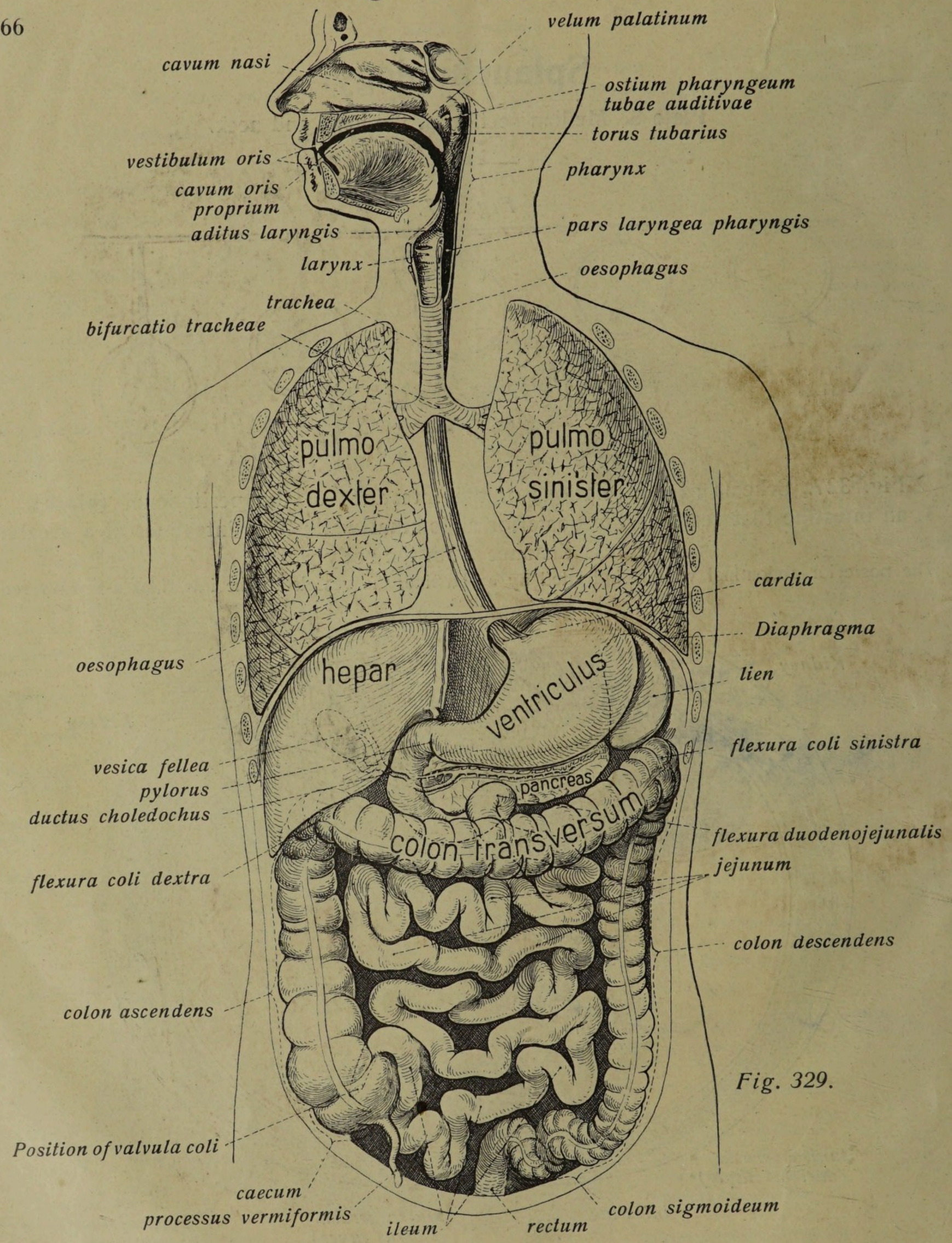


Fig. 329.

Fig. 329. Schematic representation of the digestive and respiratory organs.
Fig. 330. The region of the chin, mouth and nose, from in front. ($^4/_5$)
Fig. 331. The labial glands from behind. The mucous membrane is removed. ($^1/_1$)

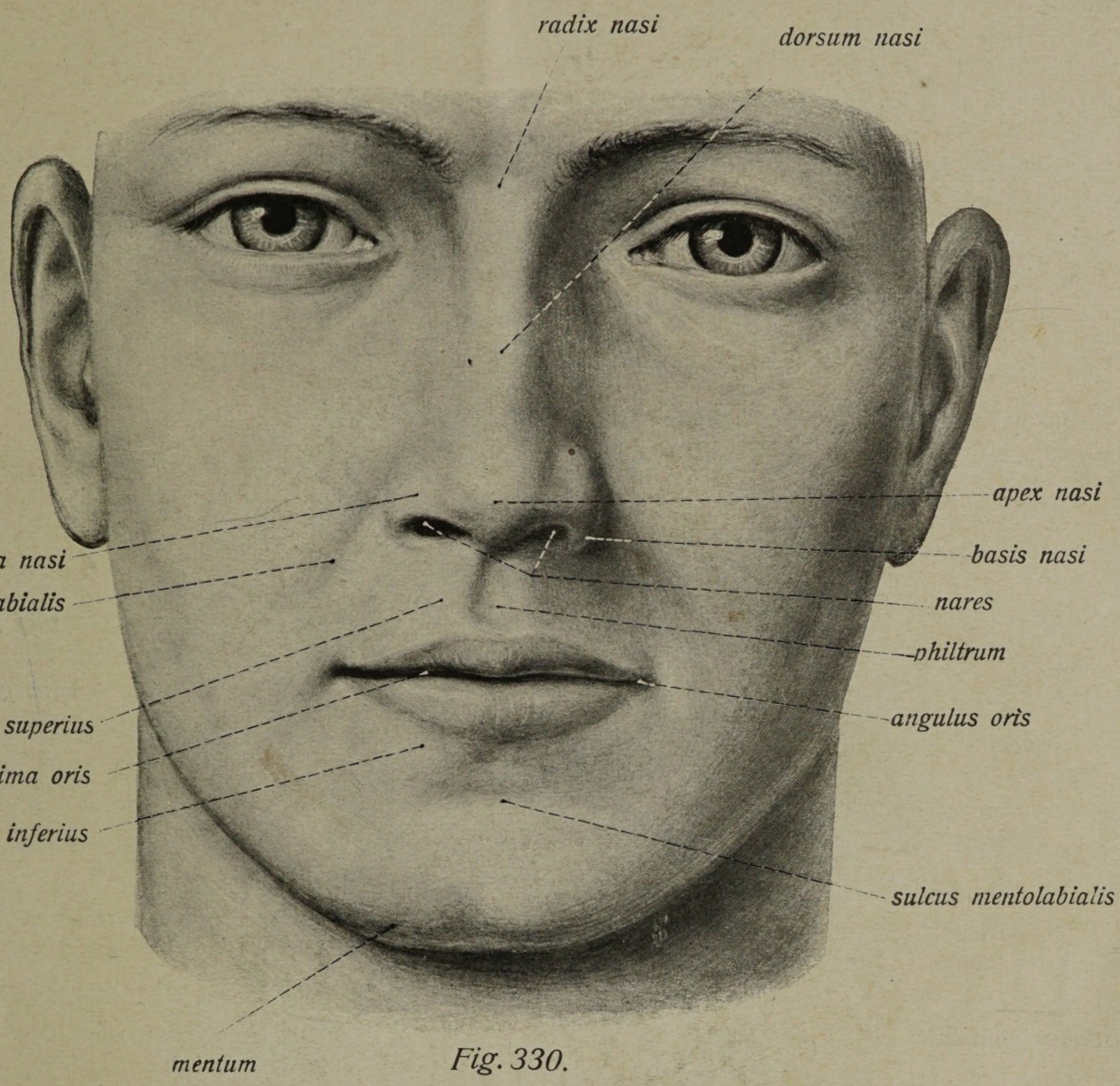


Fig. 330.

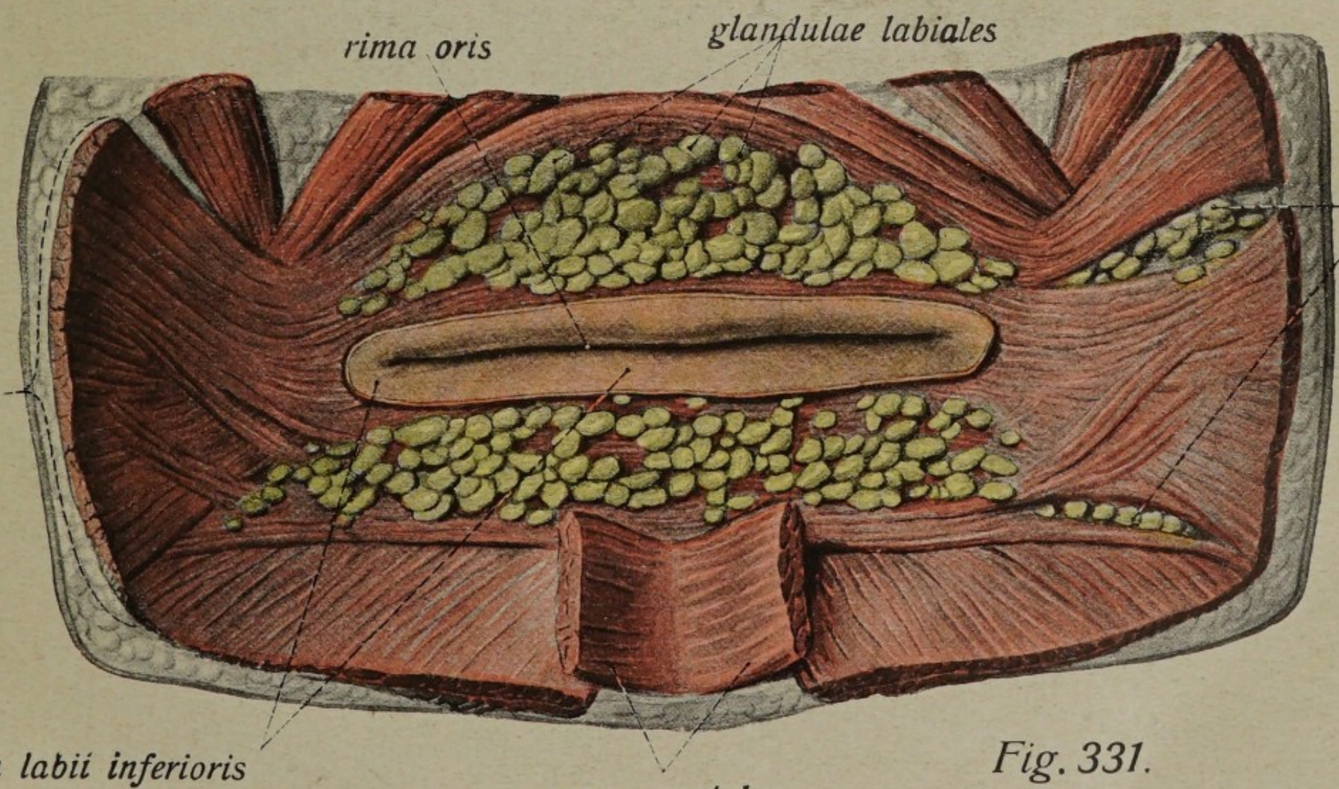


Fig. 331.

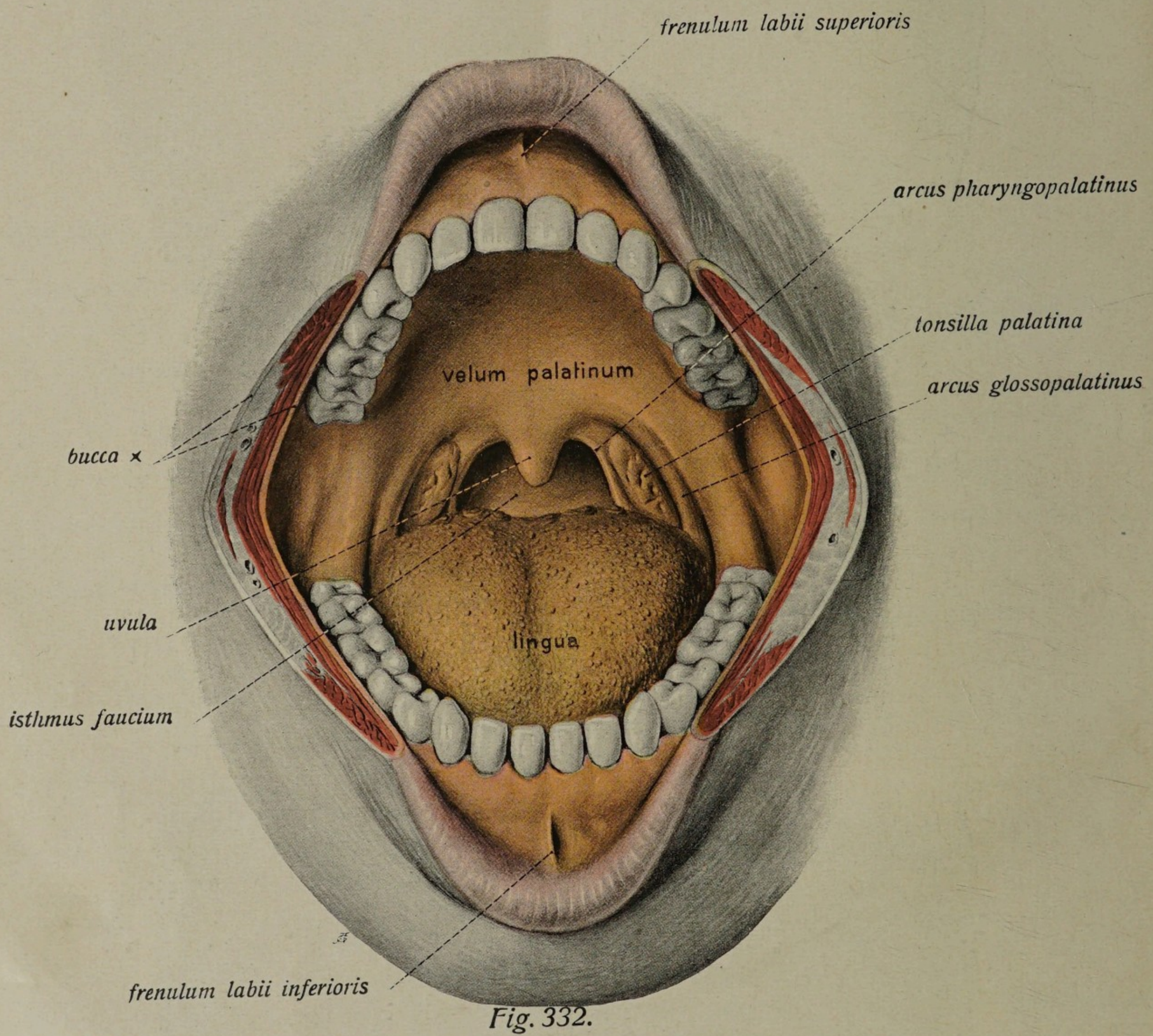

frenulum labii superioris
arcus pharyngopalatinus
tonsilla palatina
arcus glossopalatinus
velum palatinum
bucca
uvula
isthmus faucium
lingua
frenulum labii inferioris

Fig. 332.

The Digestive Organs. The Mouth Cavity.

Fig. 332. The mouth cavity from in front. ($^1/_1$) The cheeks have been cut through for a short distance from the angle of the mouth, the jaws are widely separated and the upper and lower lips drawn upwards and downwards.

The Mouth Cavity *(cavum oris)*.

The *mouth cavity (cavum oris)*, the beginning of the entire digestive tract, is an irregularly shaped, longish cavity in the lower part of the face, and has partly bony and partly muscular walls. It is divided imperfectly into two portions by the teeth, the *oral vestibule* and the *mouth cavity* proper.

The *vestibule* is a small, somewhat semicircular space, between the lips and cheeks on the one side and the teeth on the other. When the teeth are in contact, it communicates behind the last molar with the actual mouth cavity and in front through the mouth cleft *(rima oris)* with the outer world. The two lips *(labia)* form the greatest part of the anterior of the vestibule and unite at the angles of the mouth in the *labial commissures*. The *upper lip* is somewhat longer than the lower one and on its outer surface presents a flat, rather broad, median furrow, the *philtrum*. An oblique, slightly arched groove, the *nasolabial groove,* passes from the ala of the nose toward the cheek. On the outer surface of the *lower lip* the *mento-labial groove* separates the lip from the chin *(mentum)*. The lips consists of the skin with hairs, the orbicularis oris muscle and mucous membrane. This last contains the *labial glands,* which are mucous glands of small size. The posterior surfaces of the lips in the middle line are connected with the mucous membrane, *gingiva,* covering the alveolar process of the maxilla and mandible, by thin folds of mucous membrane, the *frenula,* that of the upper lip being usually the larger and more distinct.

Lateral to the lips the cheeks *(buccae)* form the wall of the oral cavity. Like the lips they consist of the skin, with stronger hairs in the male, of the buccinator muscle and of mucous membrane. The last is thin in this region and contains the *buccal glands,* which are embedded in the buccinator muscle or even lie on its outer surface. In the angle between the buccinator and the masseter there is a strong development of fat tissue, the *buccal fat pad (corpus adiposum buccae)* which extends in the new-born child over the whole region of the cheek.

The Digestive Organs. The Mouth Cavity. (Cont.)

Fig. 333. The mouth cavity and palate after dividing the cheeks. * = the radiation of the fibres of the Levator veli palatini. ($^1/_1$) On the right the mucous membrane of the palate is partly removed to show the glands; on the left the glands also are removed to show the muscles of the soft palate.

The *mouth cavity proper* is bounded above by the *palate*, which separates it from the nasal cavity. The floor of the mouth is formed principally by the tongue, which, when the mouth is closed, fills the cavity, except for a relatively small cleft between its dorsal surface and the palate. The anterior and lateral boundaries are formed by the dental arches, the posterior partly by the soft palate and the palatine arches (pillars of the fauces) and, further, at its posterior wall, it communicates with the oral portion of the pharynx by the *isthmus of the fauces*.

The *palate* consists of two portions, the *hard palate* and the *soft palate*. The former repeats the form of the palatal plates of the skeleton; its mucous membrane is thick and firm, connected closely by submucous bundles of fibres to the periosteum of the bones. It contains numerous mucous *glands*. In the median line the mucous membrane is raised into a low ridge, the *raphe*, and at the anterior end of this, at a point corresponding to the incisive foramen, there is an elongated, wart-like elevation, the *incisive papilla*, and anteriorly on either side three or four *transverse palatine folds*, which often disappear in old age, but may be in greater number in the new-born child.

The *soft palate* is a soft plate separating the mouth cavity from the nasal portion of the pharynx. It is muscular, is abundantly supplied with glands and is covered by mucous membrane on both surfaces. It is attached by its base to the posterior border of the bony palate, its mucous membrane passing directly into that of the palate, and it hangs obliquely downwards and backwards and ends in a rounded conical process, the *uvula*. This, when the palatal muscles are at rest, lies in such a position that its tip is directed forwards. The mucous membrane of the soft palate is rather smooth, much thinner than that of the hard palate, and is usually well supplied with glands. The lateral parts of the soft palate, the *palatine arches (pillars of the fauces)* are folds of mucous membrane containing muscles; they bound the *isthmus of the fauces* i. e. the transition from the mouth cavity to that of the pharynx. (see p. 305.)

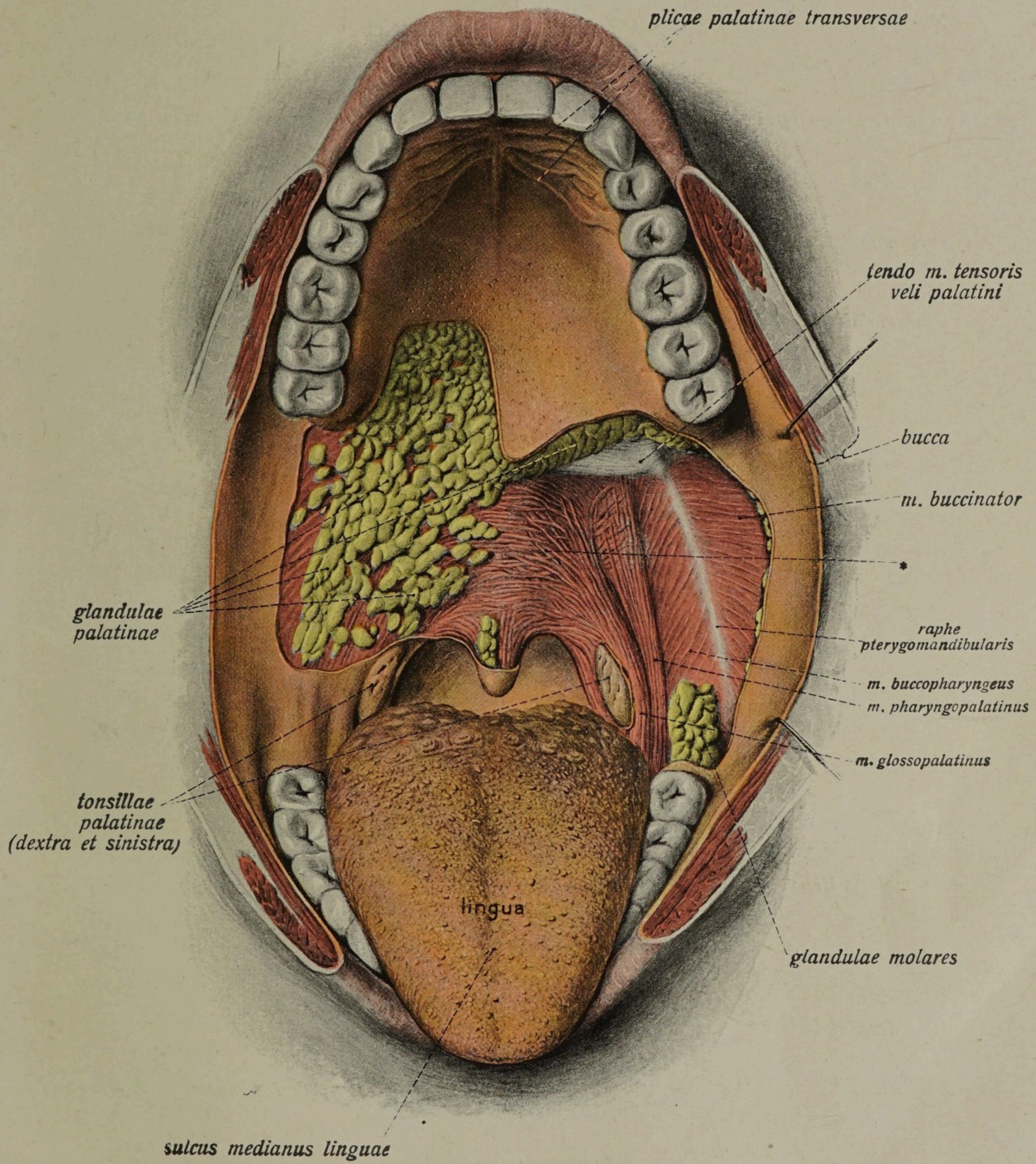

plicae palatinae transversae
tendo m. tensoris veli palatini
bucca
m. buccinator
glandulae palatinae
raphe pterygomandibularis
m. buccopharyngeus
m. pharyngopalatinus
m. glossopalatinus
tonsillae palatinae (dextra et sinistra)
lingua
glandulae molares
sulcus medianus linguae

Fig. 333.

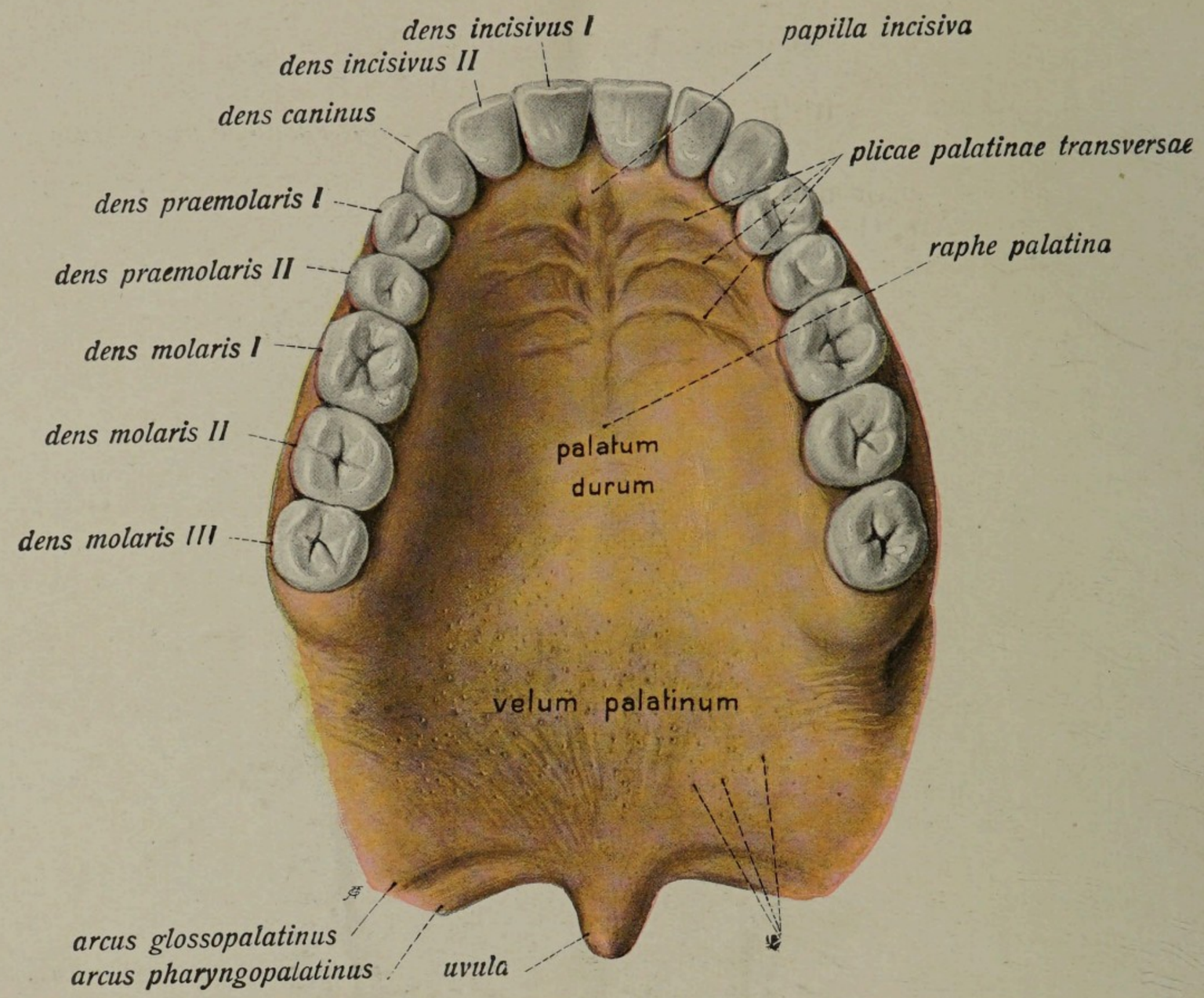


Fig. 334.

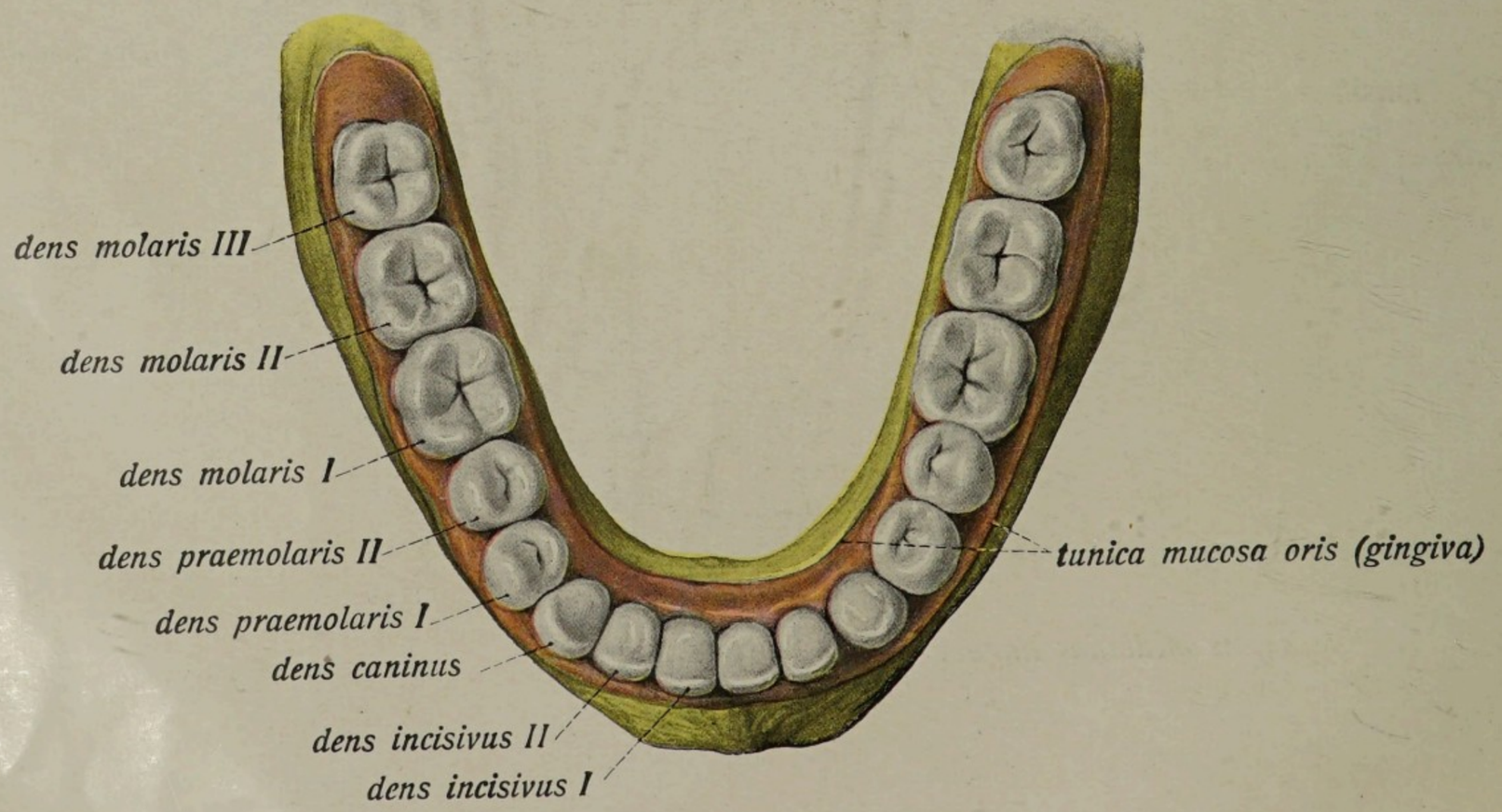


Fig. 335.

Fig. 334. The palate with the superior dental arch seen from below; the masticatory surfaces of the teeth are seen. * = openings of the palatine glands. ($^1/_1$)

Fig. 335. The inferior dental arch, from above. The masticatory surfaces of the teeth are seen. ($^1/_1$)

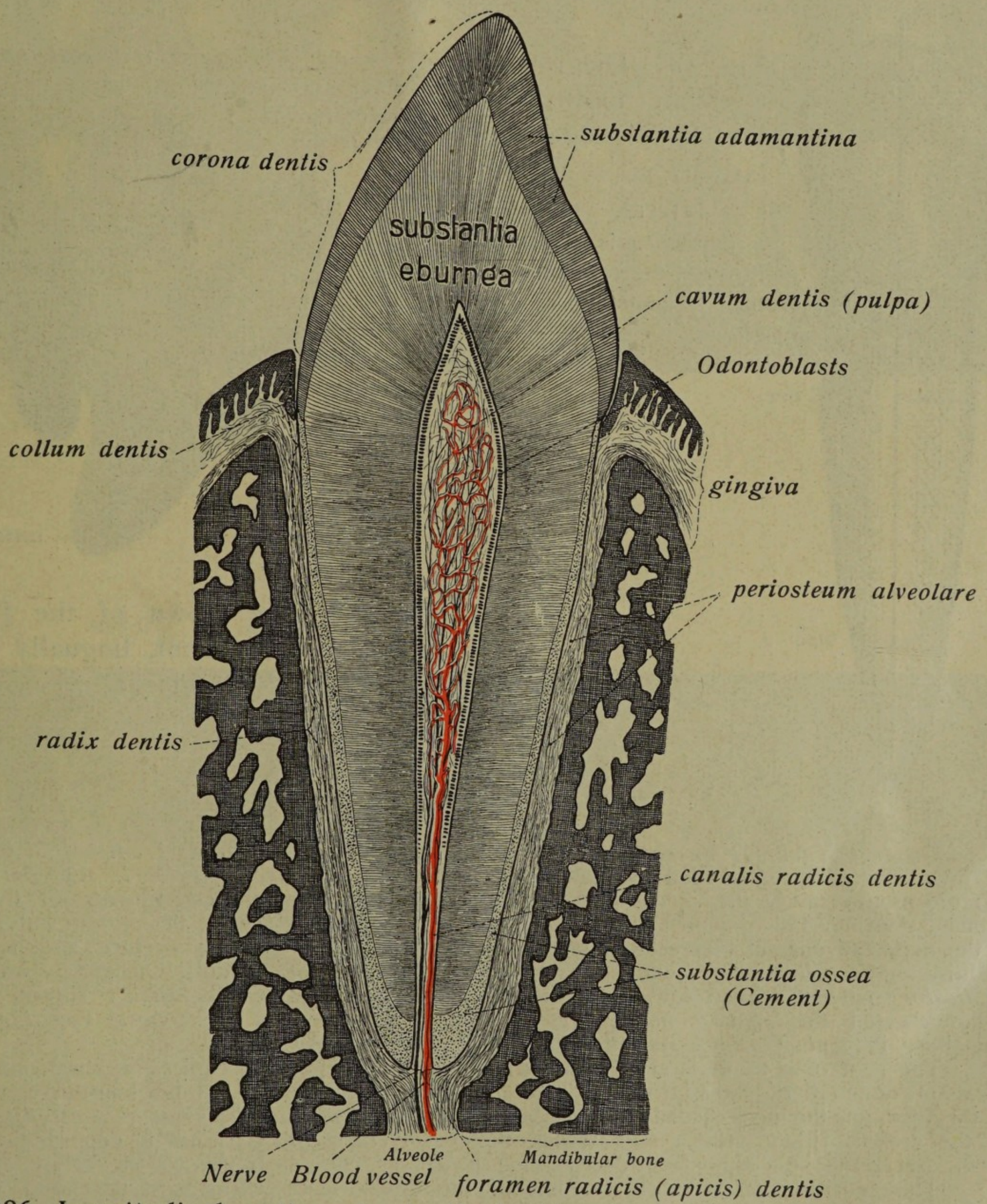


Fig. 336. Longitudinal section of a tooth in its alveolus (schematized).

Fig. 339. The upper and lower teeth from the labial or buccal surfaces. ($^1/_1$)
Fig. 340. The upper and lower teeth from the lingual surfaces. ($^1/_1$) c = canine, in = incisor, i = inferior, l = lateral, m = medial, mo = molar, pr = praemolar, s = superior.*)

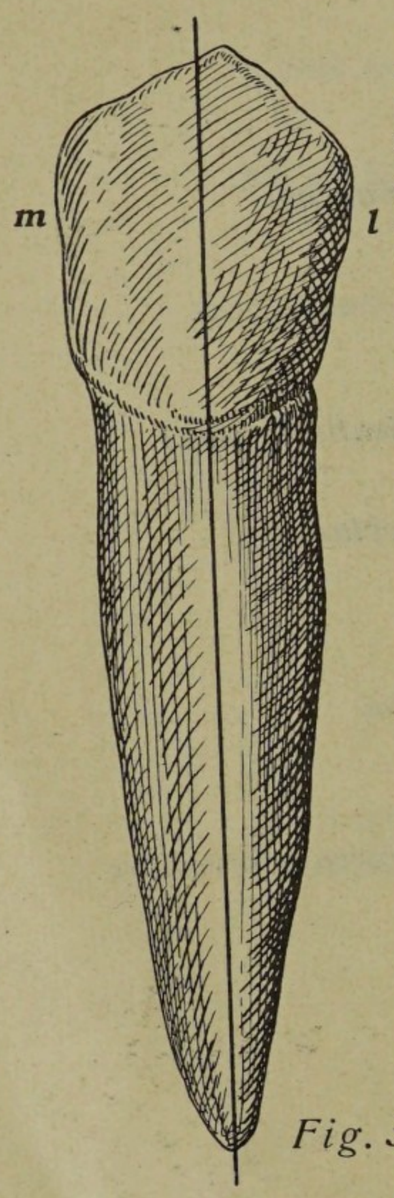


Fig. 337.

Fig. 337. Diagram of a canine tooth from the labial side (enlarged) m = medial, l = lateral.

The axis is drawn through the root to show the asymmetry of the crown.

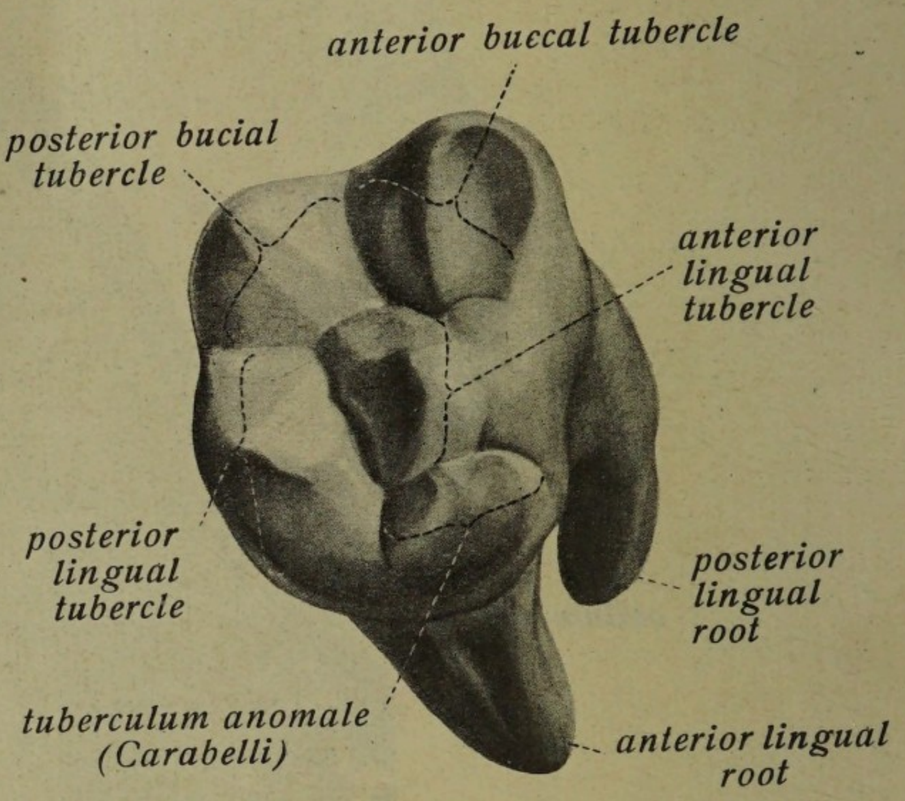


Fig. 338. The crown of the first upper molar, from in front, lingually and above (enlarged).

The Teeth.

The *teeth (dentes)* are conical structures imbedded by their roots *(radices)* in the alveoli of the jaws. The part surrounded by the gingiva is termed the *neck (collum)*, the part projecting into the mouth cavity the *crown (corona)*. Of the three principal constituents of the teeth, the enamel, dentine and cement, the enamel, occurs only on the crown, the cement only on the root; at the neck the enamel and cement meet. The enamel has a shining surface and is white with a bluish or yellowish tinge, while the cement is pale yellow and dull. On each crown there is a *masticatory surface* turned toward the teeth of the upper jaw; the surface turned towards the lips or cheek is the *labial* or *buccal surface;* that turned towards the tongue the *lingual surface;* and those in contact with adjacent teeth the *contact surfaces.*

The root of a tooth is simple or multiple and is in general conical in shape. It bears at its *apex* a foramen that leads into a *root canal*, which traverses the whole length of the root and at the level of the neck broadens to a large cavity, the *pulp cavity (cavum dentis)*, in the interior of the crown, filled with a soft tissue, the *pulp*. The pulp cavity has in general the form of the tooth, but possesses, almost regularly, fine processes corresponding to the relief of the crown.

The dentition of an adult consists of thirty-two teeth which are arranged in an upper and lower row, the *upper* and *lower dental arches*. The upper teeth are implanted in the alveoli of the maxillae, the lower in those of the mandible. The teeth of the two rows resemble each other in form and size, without being exactly alike. The number in each row is sixteen.

* Thus, for example, inil = incisor inferior lateral; prs 2 = praemolar superior 2. The apex of the canine tooth is slightly worn.

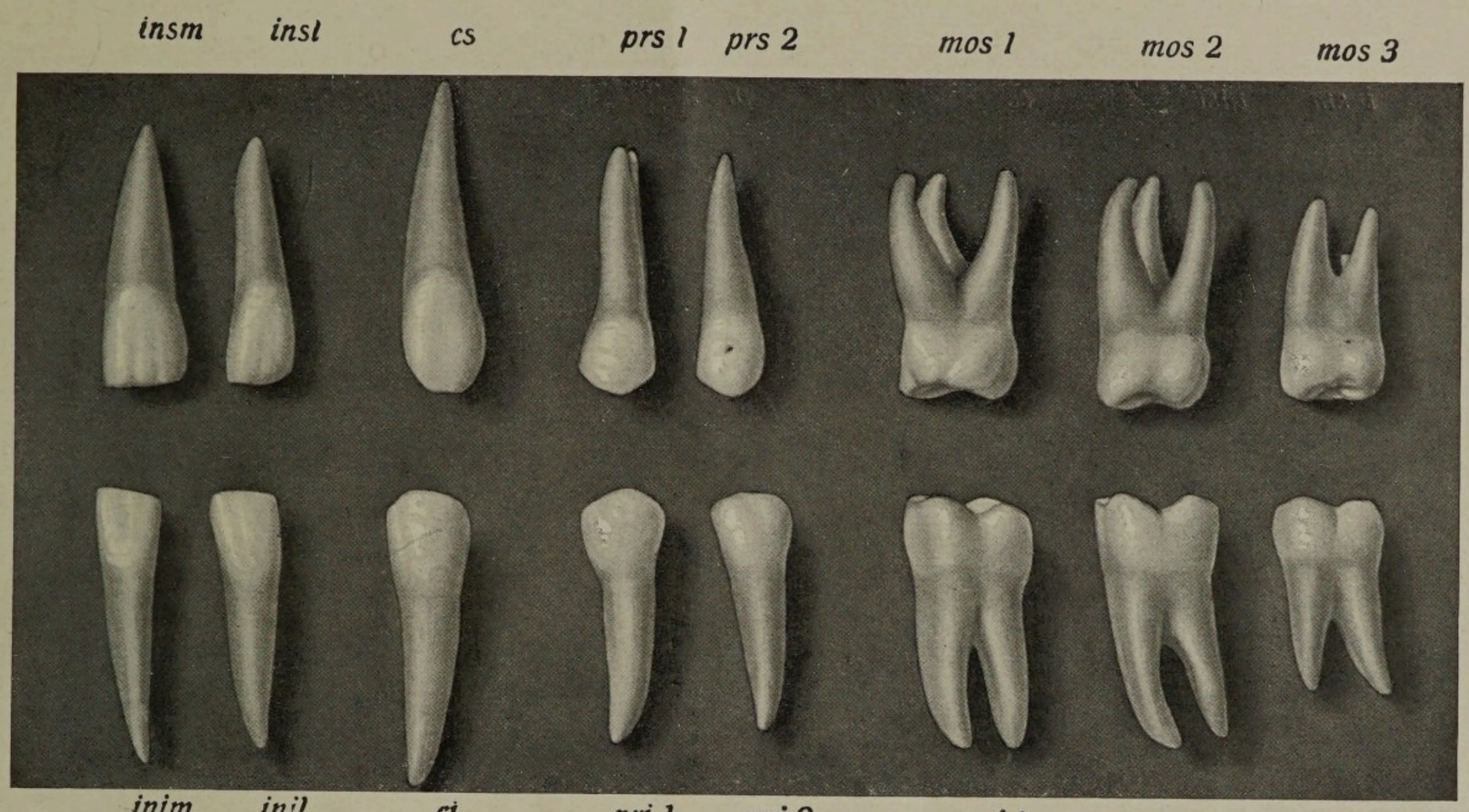


Fig. 339.

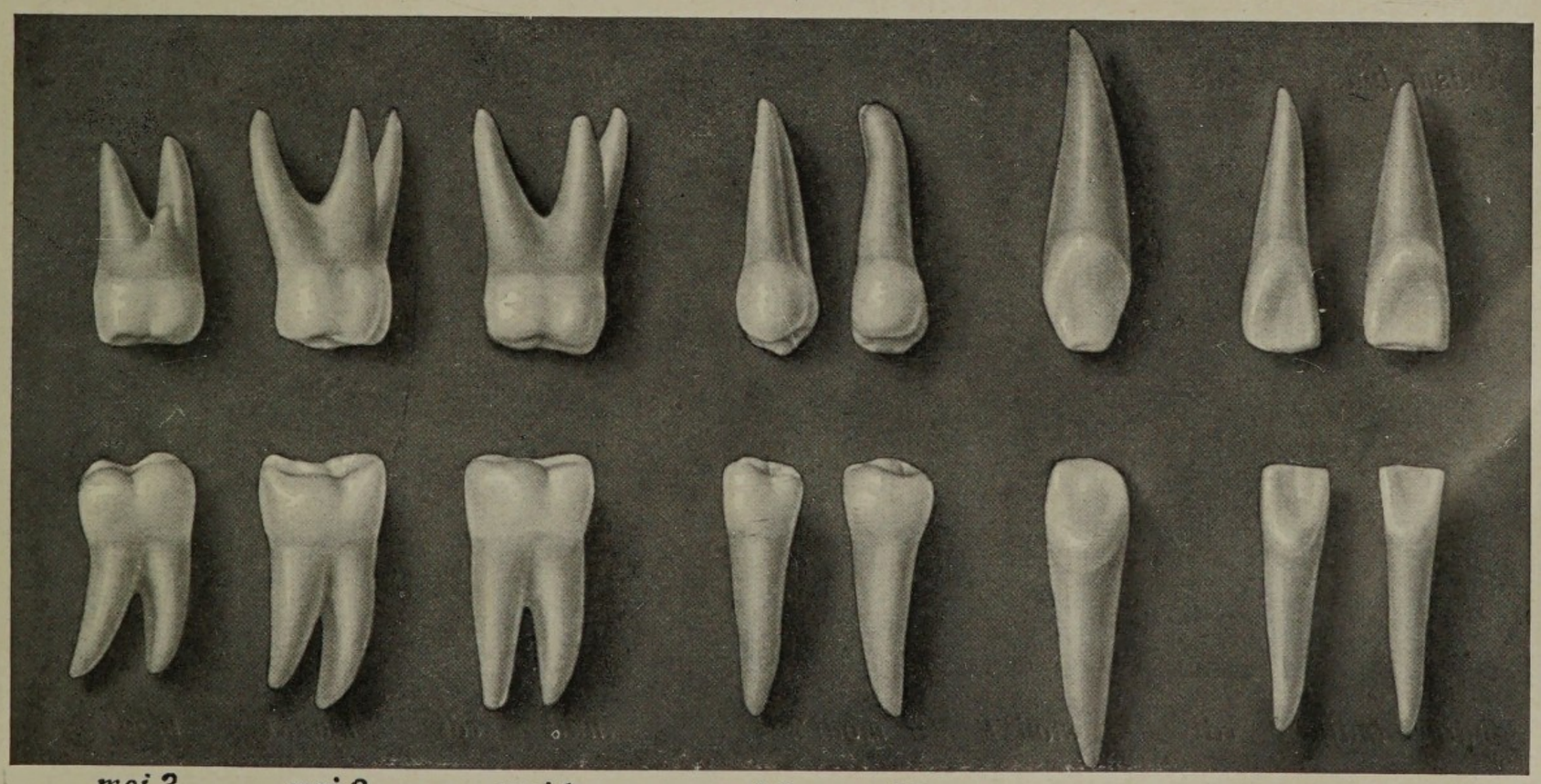


Fig. 340.

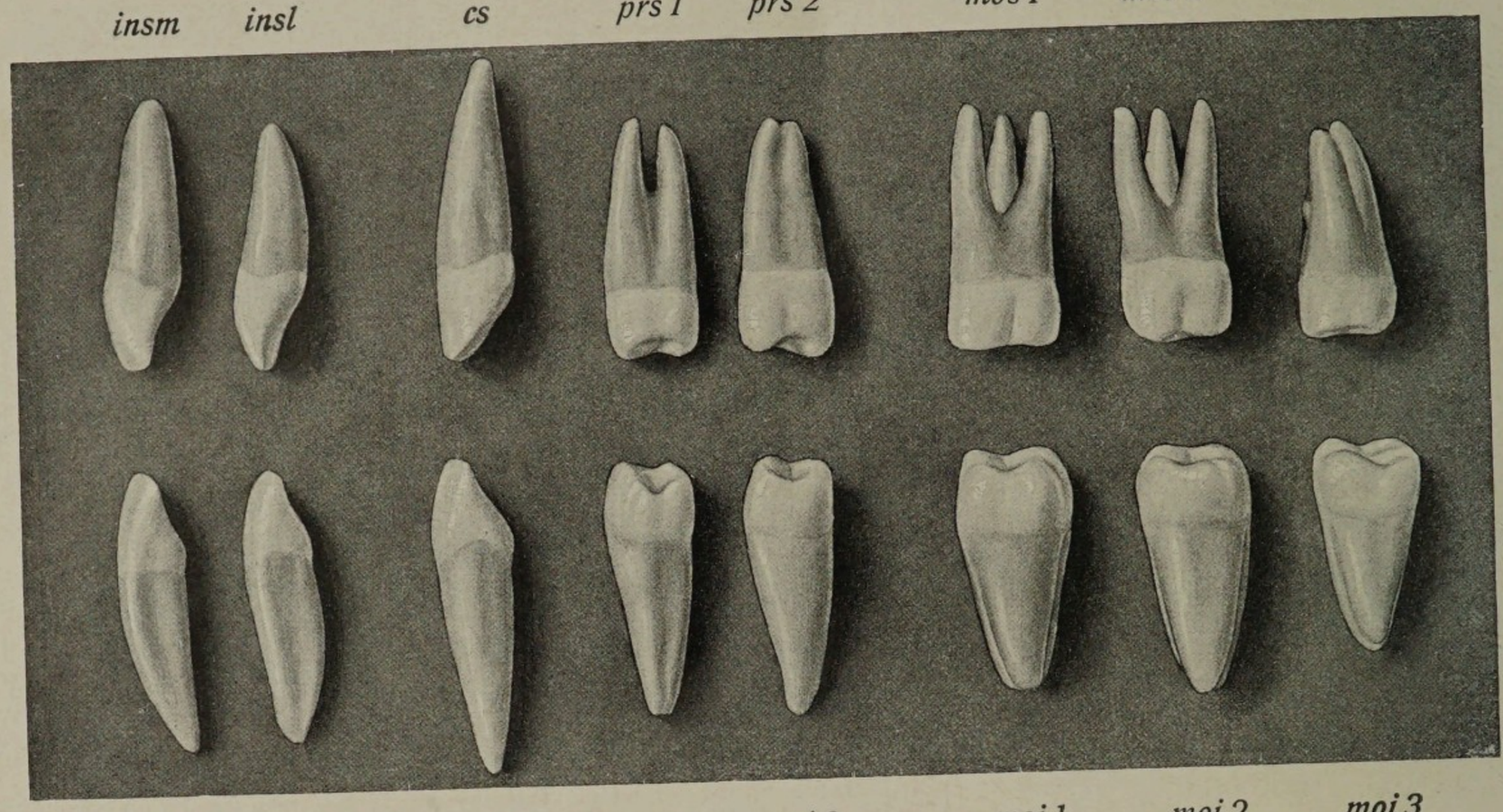


Fig. 341.

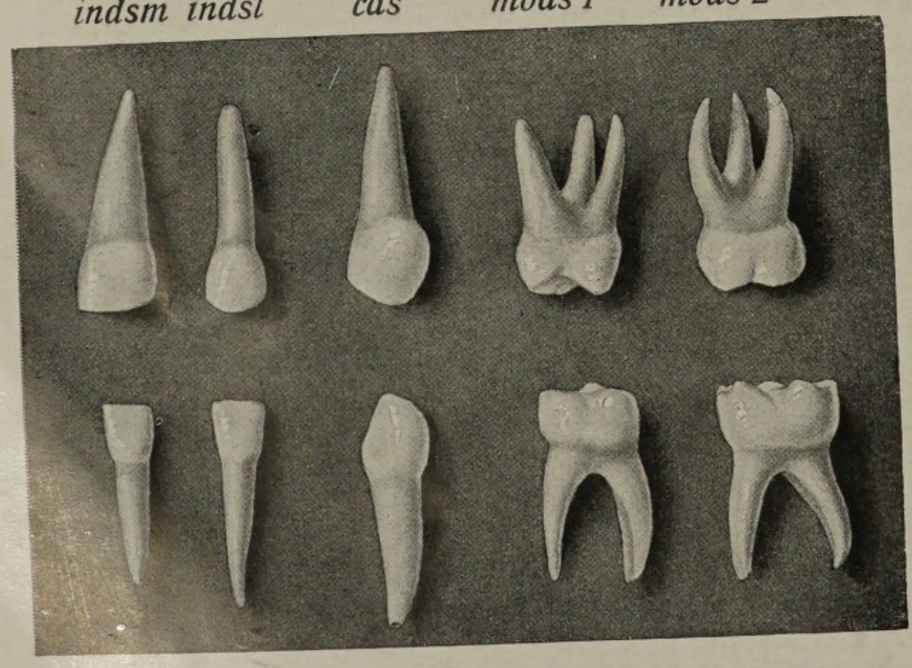


Fig. 342.

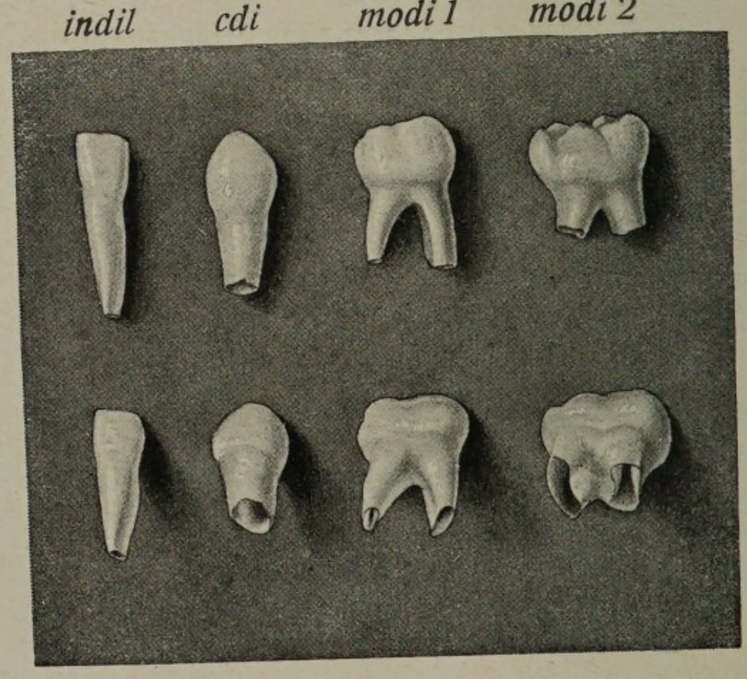


Fig. 343.

The Digestive Organs. The Teeth. (Cont.)

Fig. 341. The upper and lower teeth from the side or behind (contact surfaces). ($^1/_1$)

Fig. 342. The complete milk dentition of a three year old child, from the labial or buccal surface. ($^1/_1$)

Fig. 343. The lateral lower milk incisor, the lower milk canine and the two lower milk molars of a two-year old child, those of the upper row from the labial or buccal side, the lower obliquely from this side and from below. The roots are not yet fully developed and show four different stages. ($^1/_1$)

c = canine, d = deciduous, i = inferior, in = incisor, l = lateral, m = medial, mo = molar, pr = praemolar, s = superior. (For example, indil = incisor deciduous inferior lateral.)

The teeth of both jaws may be divided according to their form into four groups, the *incisors, canines, praemolars* and *molars*. In each half of each row there are two incisors, one canine, two praemolars and three molars. The teeth of each group represent a well-defined type, without transitions to the others, but within each type there are individual differences, as, for instance, between the corresponding teeth of the upper and lower jaws. The incisors are the most anterior, those of the two sides being in contact in the median line; then follows the canine, then the praemolars, the molars being the most posterior. The human dental formula is as follows:

M	Pm	C	J	J	C	Pm	M
3	2	1	2	2	1	2	3
3	2	1	2	2	1	2	3

$= 32.$

The *incisors* have chisel-shaped crowns, convex on the labial and concave on the lingual side; they are thicker but narrower at the base, but become broader and thinner towards their free edge. The labial surface has frequently three indistinct longitudinal ridges separated by furrows. Their crowns are in the frontal plane, so that their contact surfaces are medial and lateral. The medial border is sharp, the lateral rounded. At the base of the crown immediately above the neck there is a thickening, the *tubercle*. The roots are round, of moderate length and usually almost straight, those of the lateral incisors are usually shorter and slightly flattened. The upper ones are usually larger than the lower and the upper medial is always larger than the lateral, while in the lower jaw the lateral is the larger.

The *canines* have a long conical form. Their large and thick crown is conical and stands almost in the frontal plane, so that they present labial and lingual surfaces and medial and lateral contact surfaces. Their rounded tips are not exactly in the axis of the tooth, but slightly to the medial side, the labial surface is strongly convex and the lingual is provided with a *tubercle*. The root is very long and also conical, yet, especially in the lower ones, distinctly flattened. The canines, especially the upper ones are the longest teeth in the dentition (as a result of the long roots!).

Fig. 344. The upper and lower teeth in the skull of a man of 28 years of age, in their normal position. ($^1/_1$)

Fig. 345. The dentition of an almost one year old child. The not yet fully developed, non-erupted teeth have been exposed by chiselling away the anterior alveolar walls. ($^1/_1$)

The *praemolars* possess bitubercular (bicuspid) crowns, flattened from before backwards; their contact surfaces are anterior and posterior and their lingual and buccal surfaces convex. The two *tubercles* are separated by an almost sagittal furrow that follows the curve of the dental arch, so that there is a weaker lingual and a stronger buccal tubercle. The lingual tubercle of the first lower praemolar is usually feebly developed and the lingual of the second lower is often double, so that this tooth may be tritubercular. The roots of the lower praemolars are always simple, of moderate length and distinctly flattened; those of the upper sets vary greatly, that of the first being usually double or at least cleft, that of the second only strongly flattened or furrowed. The first upper praemolar is larger than the second.

The *molars* all possess large, low crowns with several tubercles and have two or three roots, these, as well as the positions of the tubercles differing in the upper and lower teeth. The upper molars have three roots, the larger, lower ones only two. The first molar in both the upper and lower sets has the largest and highest crown, the third the smallest and lowest. The tubercles are four, rarely five in number, two being on the lingual and two on the buccal side. In the lower molars a rather regular crucial furrow separates the four tubercles, of which the lingual are higher than the buccal. The first lower molar has usually five tubercles, three buccal and two lingual. In the upper molars the buccal tubercles are higher than the lingual and the intervening furrow has the form of an oblique H, so that the lingual and buccal tubercles are not exactly opposite one another*). The contact surfaces of the molars are anterior and posterior.

The lower molars have two, rarely more, roots, an anterior and a posterior; they are flattened in the frontal plane, are furrowed and of considerable size, and their tips are usually curved backwards. The upper molars, on the contrary, have three conical roots, two buccal and one lingual or palatal; their tips are also curved. All three roots are usually well developed in the first upper molar; in the second they show, not infrequently, more or less fusion, and this is the rule in the third upper one.

* Frequently, but not always, the first upper molar has a super-numerary tubercle, usually very small, at the base of the anterior lingual tubercle. It is the so-called anomalous (Carabelli) tubercle.

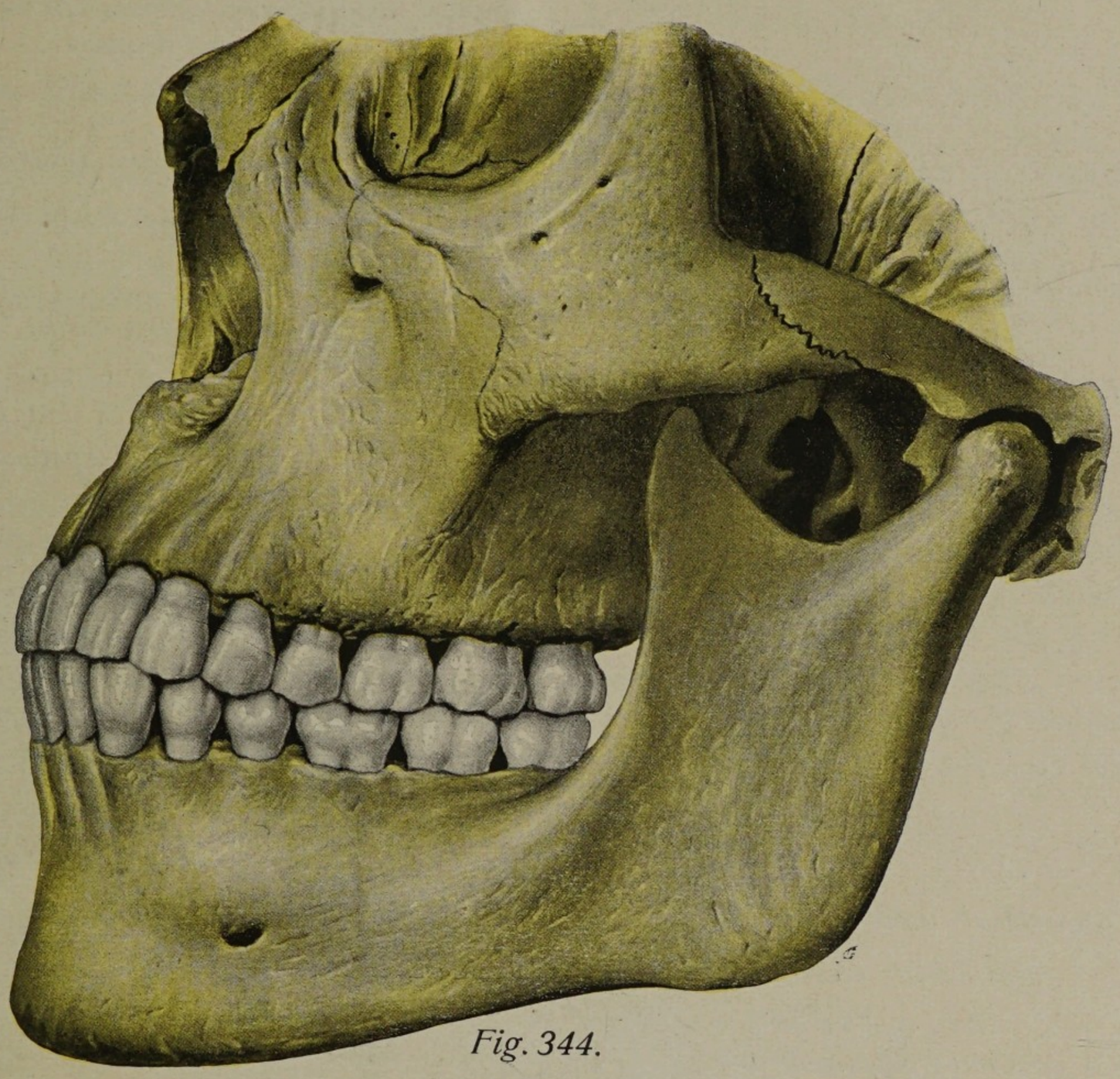


Fig. 344.

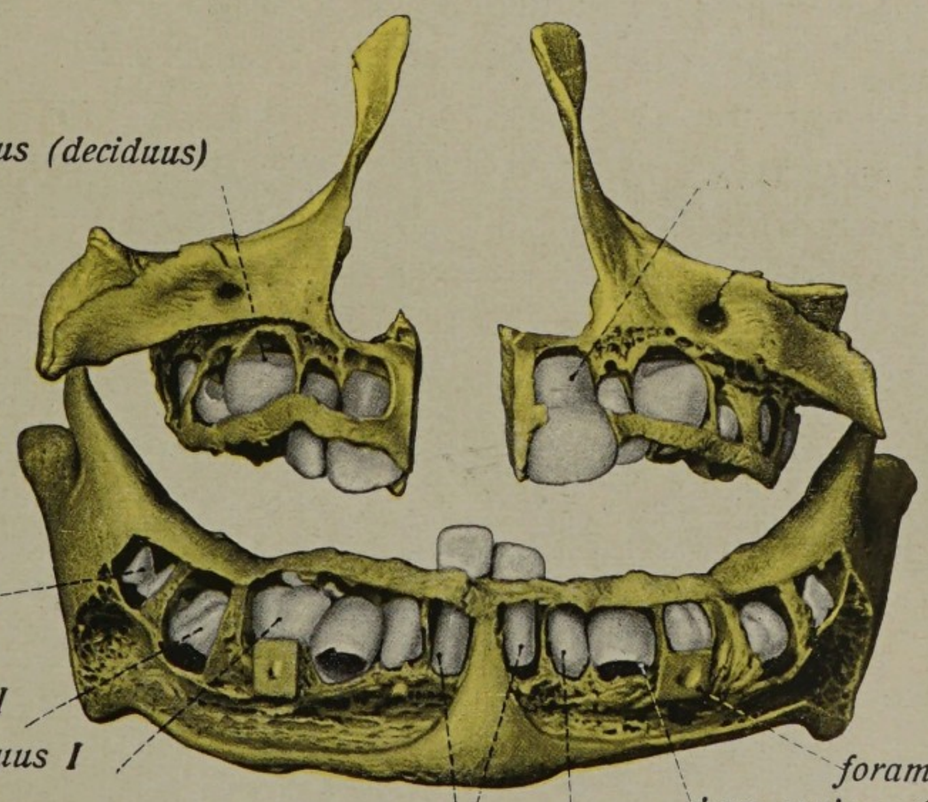


Fig. 345.

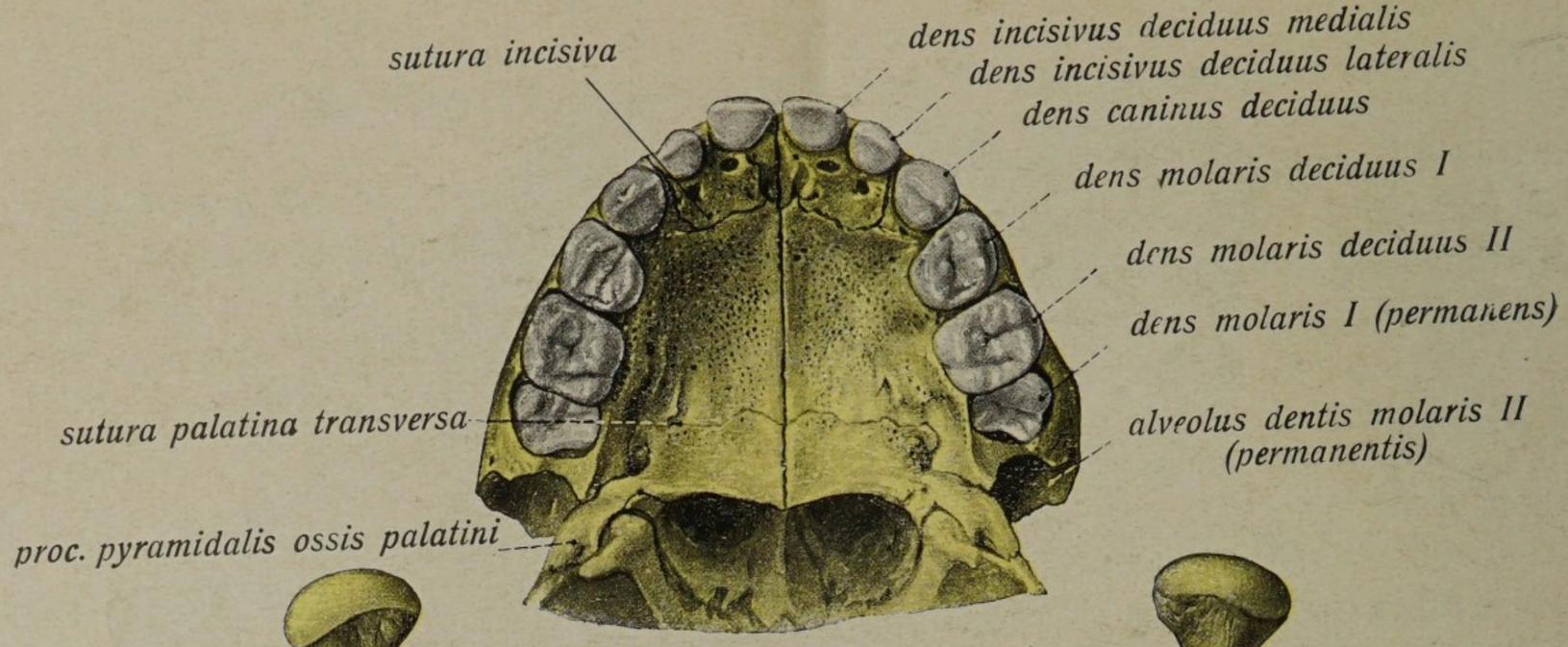


Fig. 346.

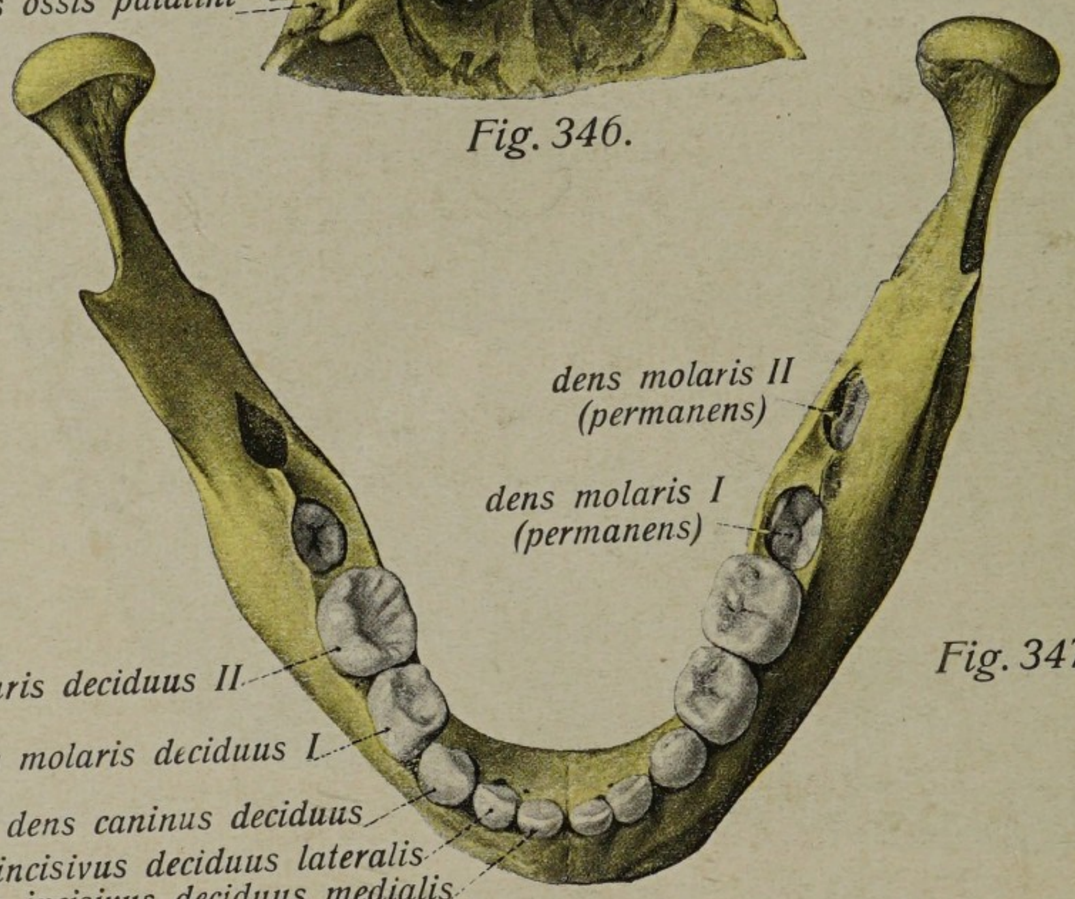


Fig. 347.

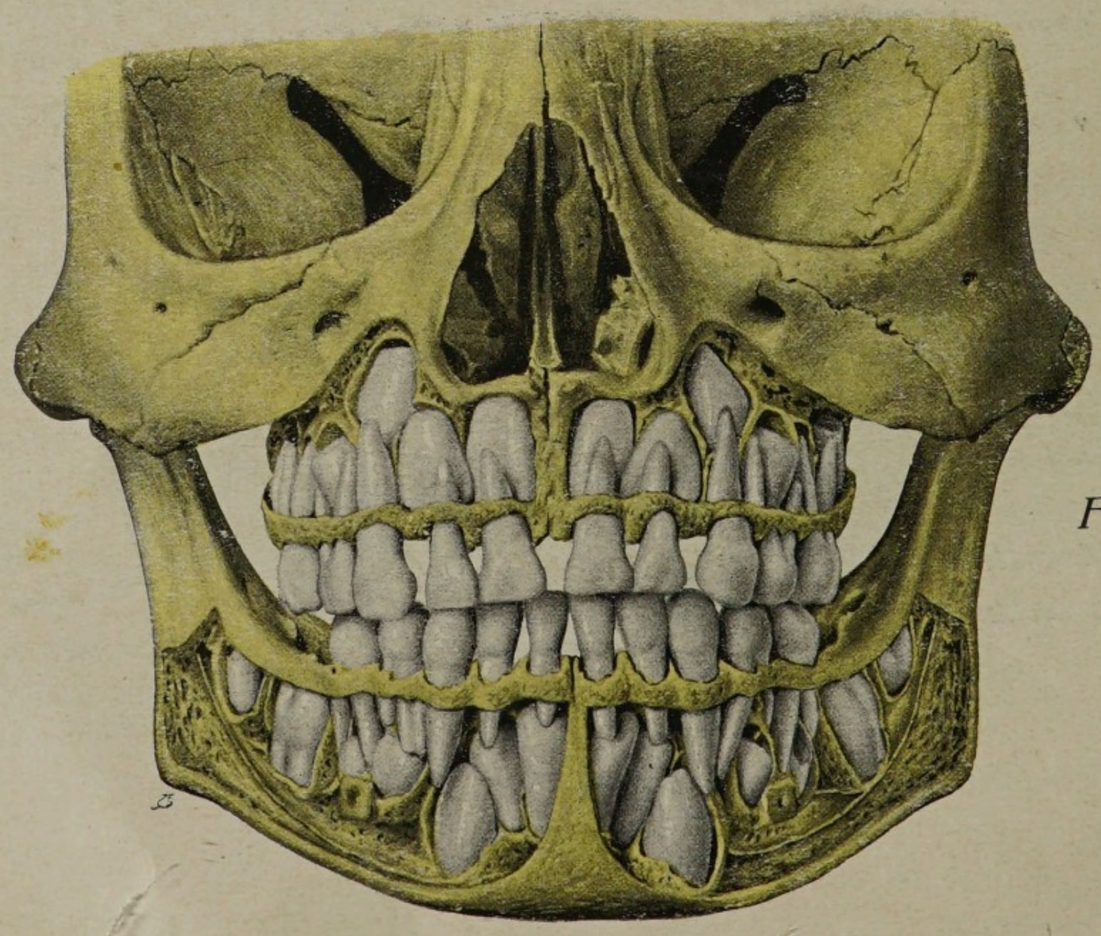


Fig. 348.

The Digestive Organs. The Teeth. (Cont.)

Fig. 346. The upper teeth of the milk dentition of a child of four years. ($^1/_1$)
Fig. 347. The lower teeth of a child of four years. ($^1/_1$)
Fig. 348 and 349. The skull of a child of five years with the milk dentition and the anlagen of the permanent teeth, from in front. The permanent teeth and the roots of the milk teeth have been exposed by chiselling away the alveoli. In Fig. 349 the permanent teeth are blue. ($^1/_1$)

The third molars, also called *wisdom teeth (dentes serotini),* are usually more or less rudimentary. The upper is always much smaller than the lower and its roots usually fuse to a single mass with indications, in three root canals, of their original triple division. Often they possess only two tubercles. The lower wisdom tooth has usually two short roots and a crown that departs somewhat from the type.

The permanent dentition of the adult, consisting of thirty-two teeth, is preceded in childhood by a dentition of only twenty teeth *(dentes decidui)* including eight incisors, four canines and eight molars. The formula for the milk dentition is therefore:

$$\frac{\begin{matrix} M & C & J \\ 2 & 1 & 2 \end{matrix} \;\Big|\; \begin{matrix} J & C & M \\ 2 & 1 & 2 \end{matrix}}{\begin{matrix} 2 & 1 & 2 \end{matrix} \;\Big|\; \begin{matrix} 2 & 1 & 2 \end{matrix}} = 20.$$

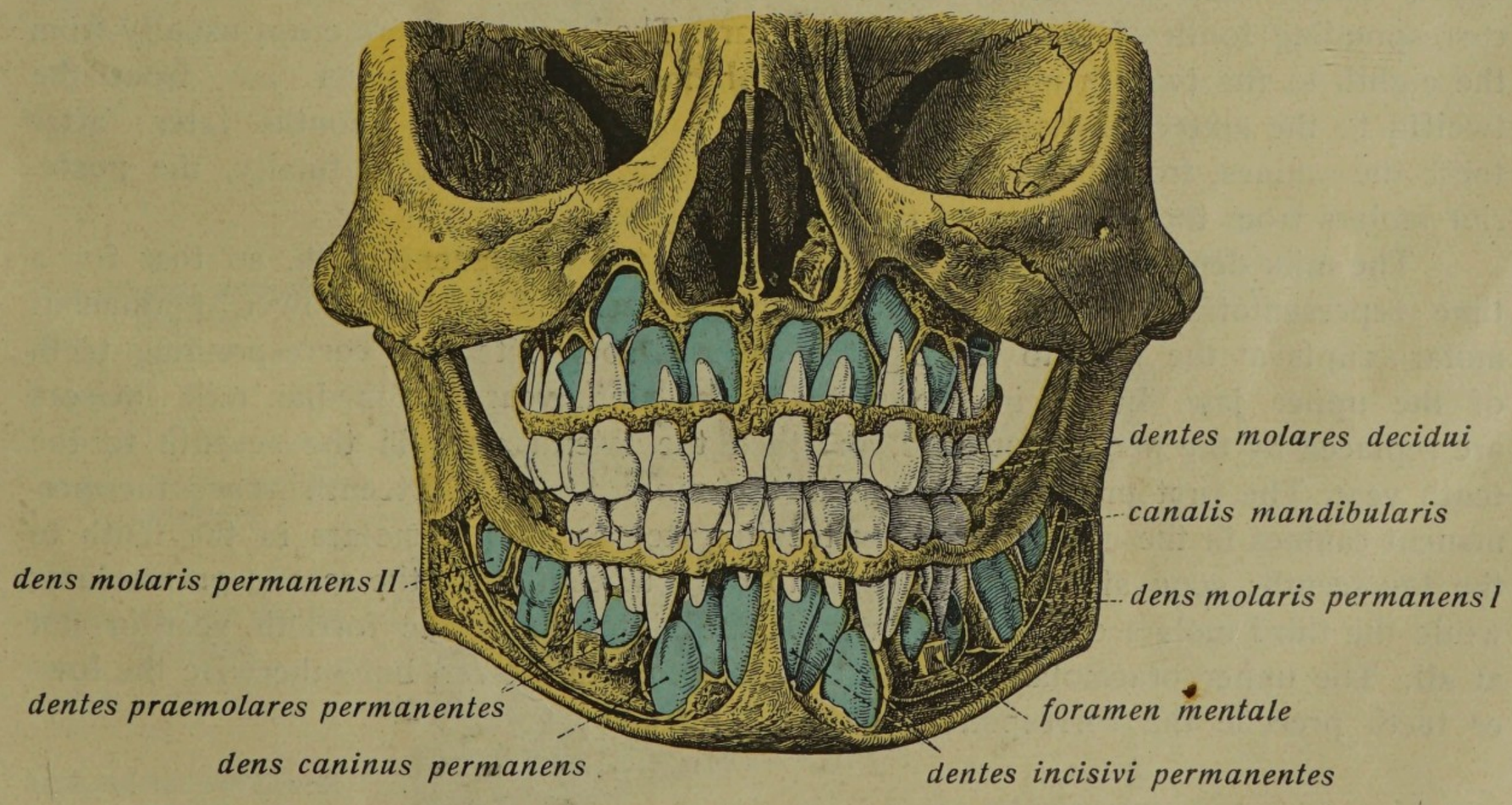


Fig. 349.

Fig. 350. The skull of a child of five years with the milk dentition and the anlagen of the permanent teeth. The same preparation as Fig. 348—349, but from the left side. ($^1/_1$)

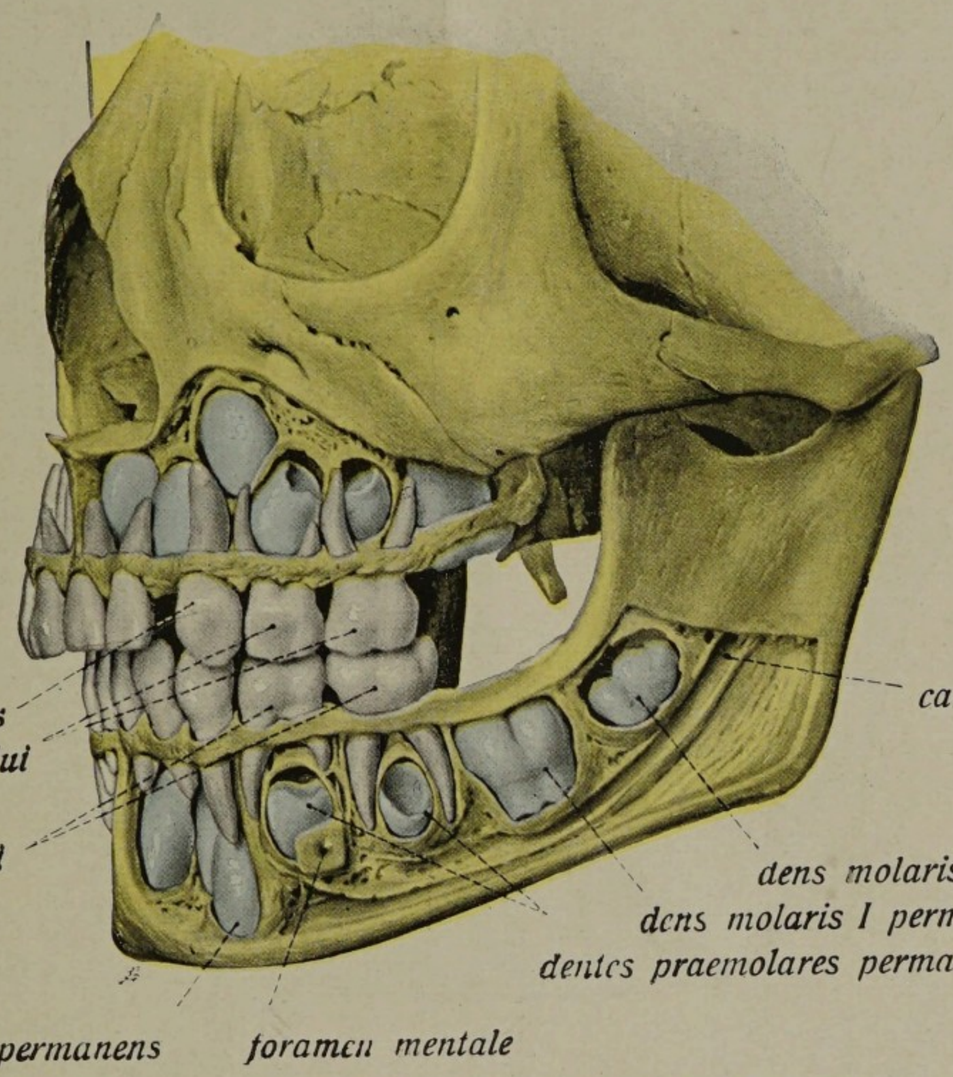
Fig. 351. The milk dentition and anlagen of the permanent teeth in a child of nine years, from the left side. The roots and the not yet erupted teeth are exposed by chiselling away the alveoli. ($^1/_1$)

In Fig. 350 and 351 the anlagen of the permanent teeth are blue.

The incisors and canines of the milk dentition resemble the corresponding teeth of the permanent dentition not only in general but also in particular, though they are relatively smaller and the furrows are wanting on the labial surfaces of the crowns of the incisors. These teeth also occur in the same position as their successors, while the milk molars appear in the places later occupied by the praemolars. The milk molars, while resembling the permanent ones, represent a specific type; they have more than one root and have several tubercles. The second (posterior) are larger than the first; the upper ones have usually three roots like the permanent molars, two buccal and one lingual, while the lower have two roots. The crowns have from three to five regularly placed tubercles, which are separated by very irregular furrows.

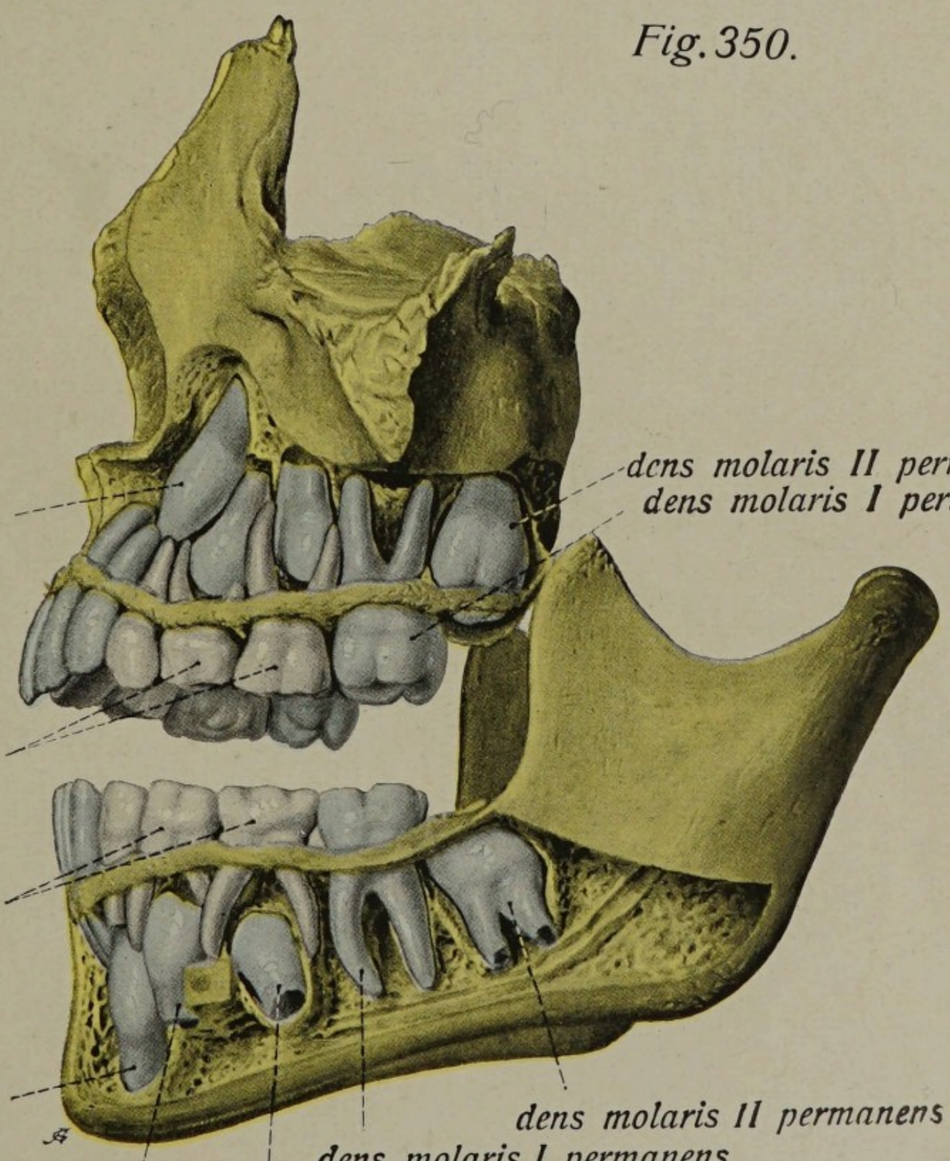
The first milk tooth to erupt, on the average, in the sixth or seventh month after birth, is the medial incisor of the lower jaw and, as a rule, the teeth of the lower jaw appear earlier than those of the upper. Then, in the seventh or eighth month the corresponding tooth of the upper jaw appears. The lateral incisors erupt usually from the eighth to the twelfth month; the anterior molars of the lower jaw from the twelfth to the sixteenth month; those of the upper jaw some months later; after these the canines, from the sixteenth to the twentieth month; and, finally, the posterior molars from the twentieth to the thirtieth month.

The milk dentition is gradually replaced by the permanent teeth, so that for a time representatives of both dentitions are present. The first, lower, permanent molar erupts at the fifth to the eighth year and soon after the corresponding teeth of the upper jaw. Later, in the sixth to the ninth year, the median milk incisors are replaced by the permanent ones, and then the lateral ones in the seventh to the tenth year. The first praemolars erupt in the ninth to the thirteenth year; the permanent canines in the ninth to the fourteenth; the second praemolars in the tenth to the fourteenth; soon after, in the tenth to the fourteenth year the second praemolars; while the third molars erupt much later, in the sixteenth to the fortieth year or not at all. The upper praemolars usually appear before the lower, but otherwise the lower teeth precede the corresponding upper ones.



dens caninus deciduus
dentes molares decidui superiores
dentes molares decidui inferiores
canalis mandibularis
dens molaris II permanens
dens molaris I permanens
dentes praemolares permanentes
dens caninus permanens
foramen mentale

Fig. 350.



dens caninus permanens superior
dentes molares decidui superiores
dentes molares decidui inferiores
dens caninus permanens inferior
dens praemolaris I (permanens)
dens molaris II permanens
dens molaris I permanens
dens praemolaris II (permanens)
dens molaris II permanens
dens molaris I permanens

Fig. 351.

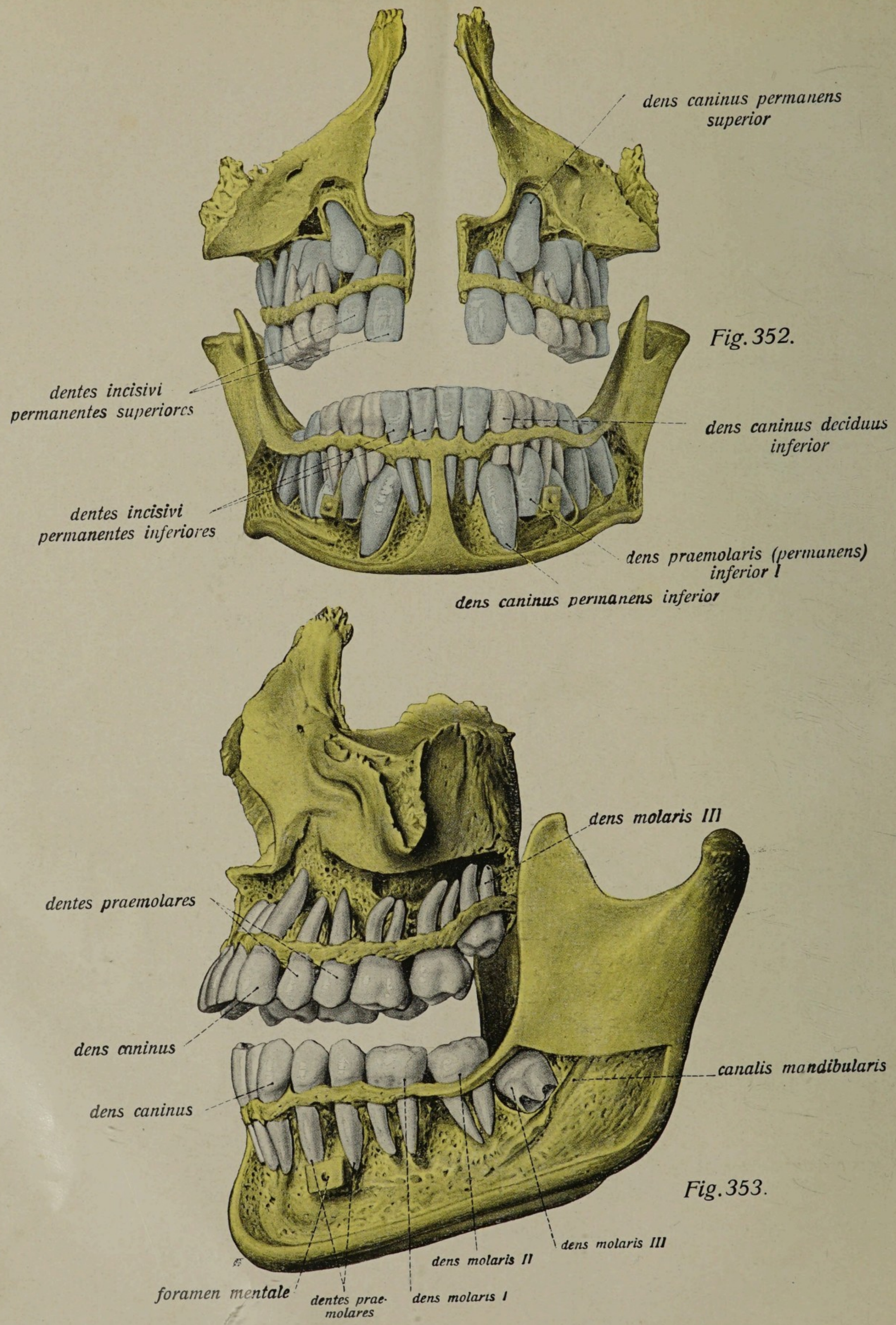


Fig. 352.

Fig. 353.

The Digestive Organs. The Teeth. (Cont.)

Fig. 352. The same preparation as Fig. 349, but from in front. ($^1/_1$)

Fig. 353. The upper and lower jaws of a person of twenty years, from the side. All the teeth have erupted, except the third molars. ($^1/_1$)
The roots of the teeth have been exposed by chiselling away the alveolar walls. In Fig. 352 the permanent teeth are blue.

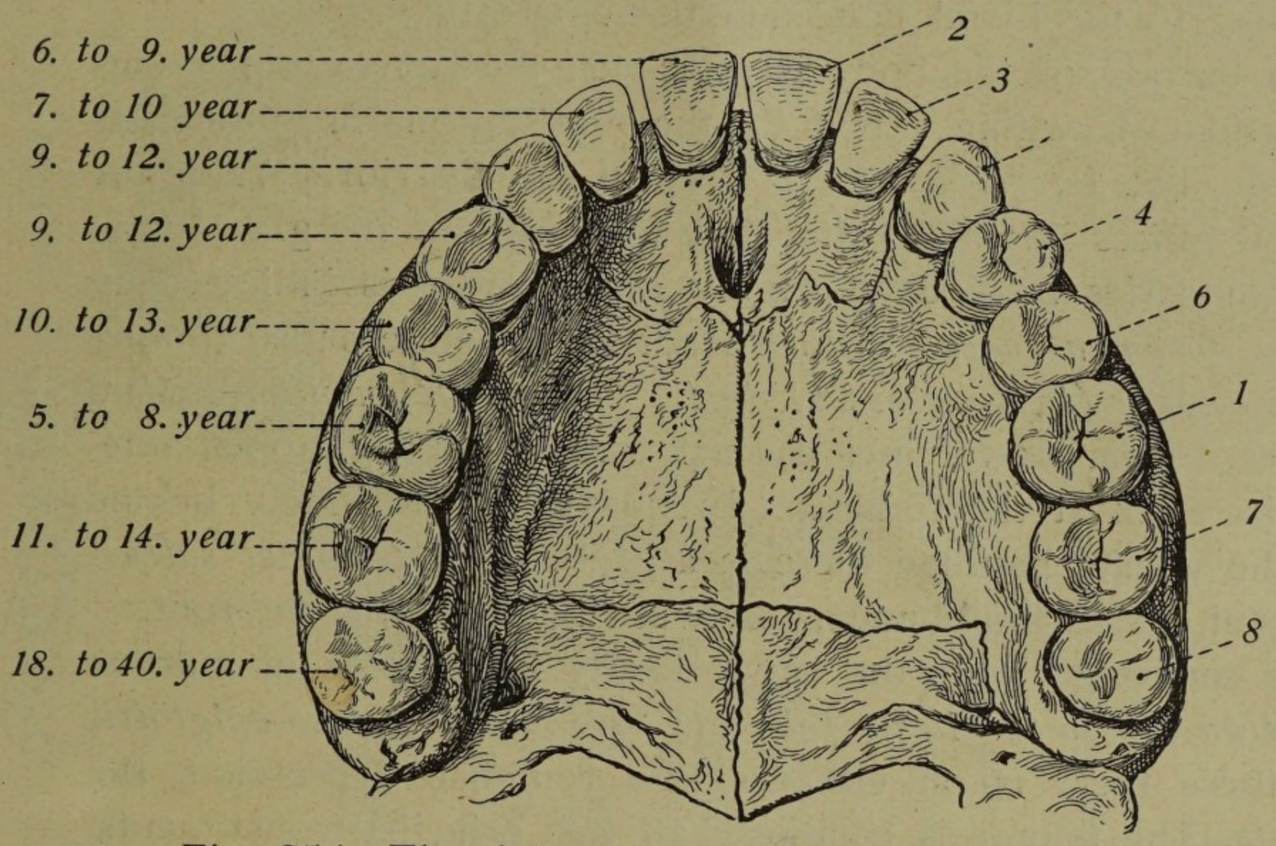


Fig. 354. The dates of eruption of the permanent teeth.
On the right are given the dates of eruption, on the left the order of appearance.

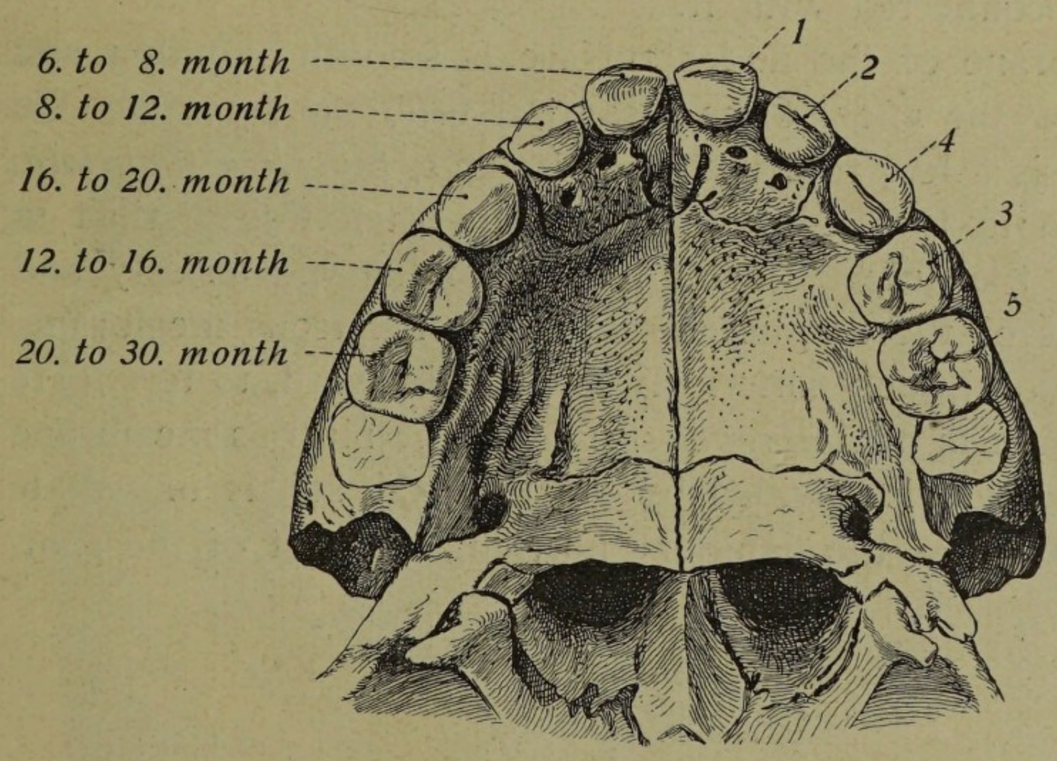


Fig. 355. The dates of eruption of the milk teeth.
On the right are given their dates of eruption, on the left the order of succession.

The Tongue.

The tongue *(lingua)* presents for examination three parts, a *body (corpus)*, the largest, middle portion, adherent to the floor of the mouth, an *apex* projecting freely into the mouth cavity anteriorly and a *root (radix)* posteriorly, attached to the hyoid bone and the epiglottis.

The inferior surface of the body is attached; the convex upper surface, lined throughout its whole extent by the oral mucous membrane, is termed the *dorsum*. The *lateral border* is free in the anterior part of the tongue, but behind passes into the soft palate by means of the glossopalatine arch. The boundaries between the body and the root is indicated on the dorsum by the *foramen caecum*, which leads into a quite short, blindly ending canal, the *lingual (thyreoglossal) duct*. The *vallate papillae* extend outward and forward from the foramen caecum, forming an angle open anteriorly and with its apex at the foramen. Frequently, immediately behind and parallel to the vallate papillae there is a groove, the *terminal sulcus*, which, when present, marks the boundary between the body and the root.

The root is connected with the epiglottis by three folds of mucous membrane, *a median glosso-epiglottic fold* and two *lateral glosso-epiglottic* folds. Between these there is on either side a roundish depression, the *epiglottic vallecula*. The tongue is composed of two principal constituents, the mucous membrane and muscles. The mucous membrane of the dorsum is intimately connected with the subjacent muscle tissue, that of the under surface is only loosely connected with it.

The mucous membrane of the under surface is smooth and thin and in the median line below the apex forms a sagittal fold, the *frenulum*. On either side of this there is a low fold with lobed edges, the *plica fimbriata*, which is well developed in the new-born child, but often less distinct in the adult. It runs from the anterior end of the frenulum posteriorly and laterally. At the margins of the tongue another fold of mucous membrane, the *sublingual fold*, runs obliquely anteriorly and mediánward, to terminate at the root of the frenulum in a *sublingual caruncle*. The mucous membrane of the dorsum of the tongue is divided by the terminal sulcus or vallate papillae into that of the body, the papillary portion, and that of the root, the tonsillar portion.

Fig. 356. The sublingual region, the mouth being widely opened and the tip of the tongue raised. (4/5)
Fig. 357. The dorsal surface of the tongue as seen when the organ is removed from the mouth entire. (1/1)

Fig. 357. The dorsal surface of the tongue as seen when the organ is removed from the mouth entire. (1/1)

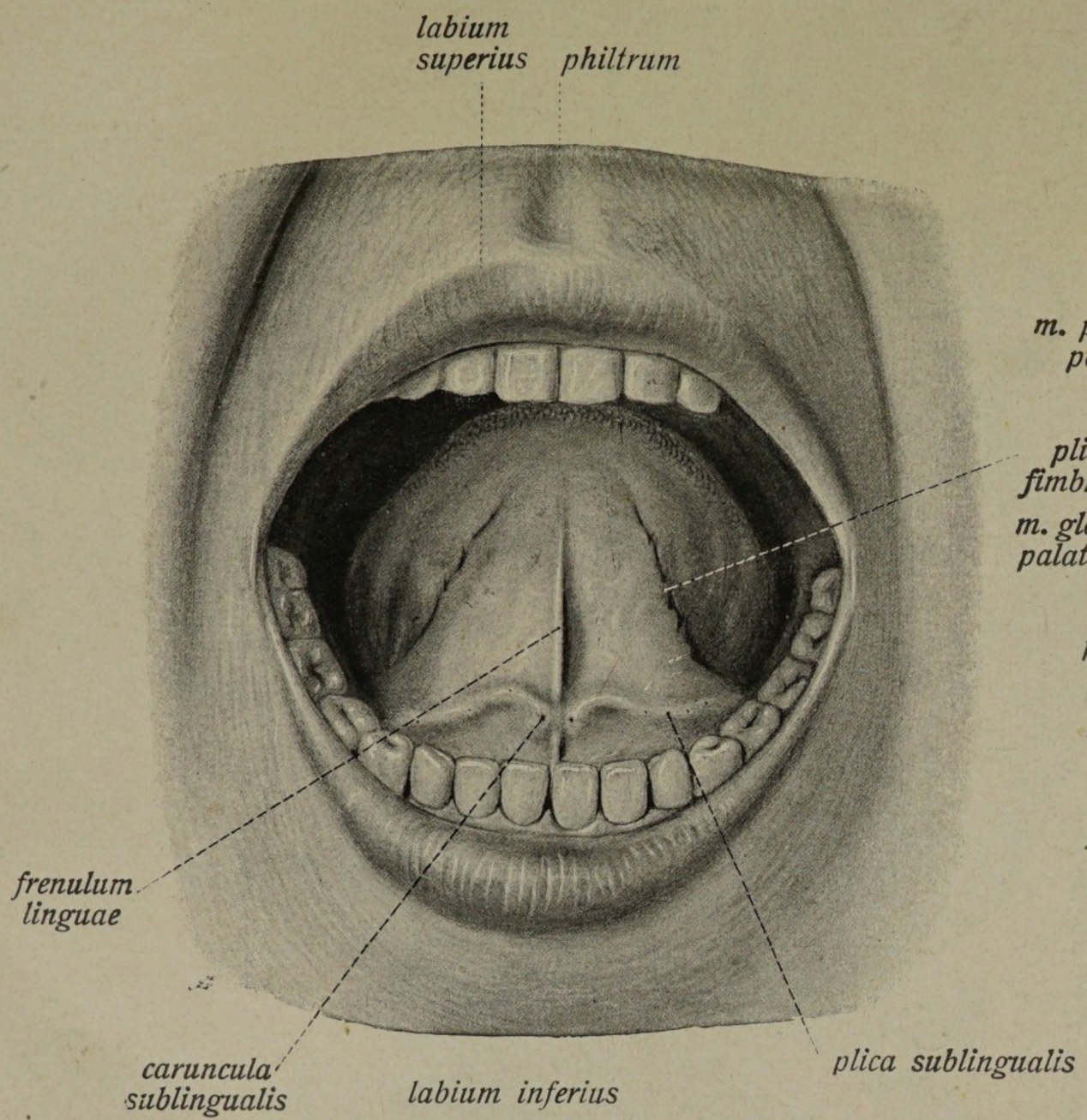


Fig. 356.

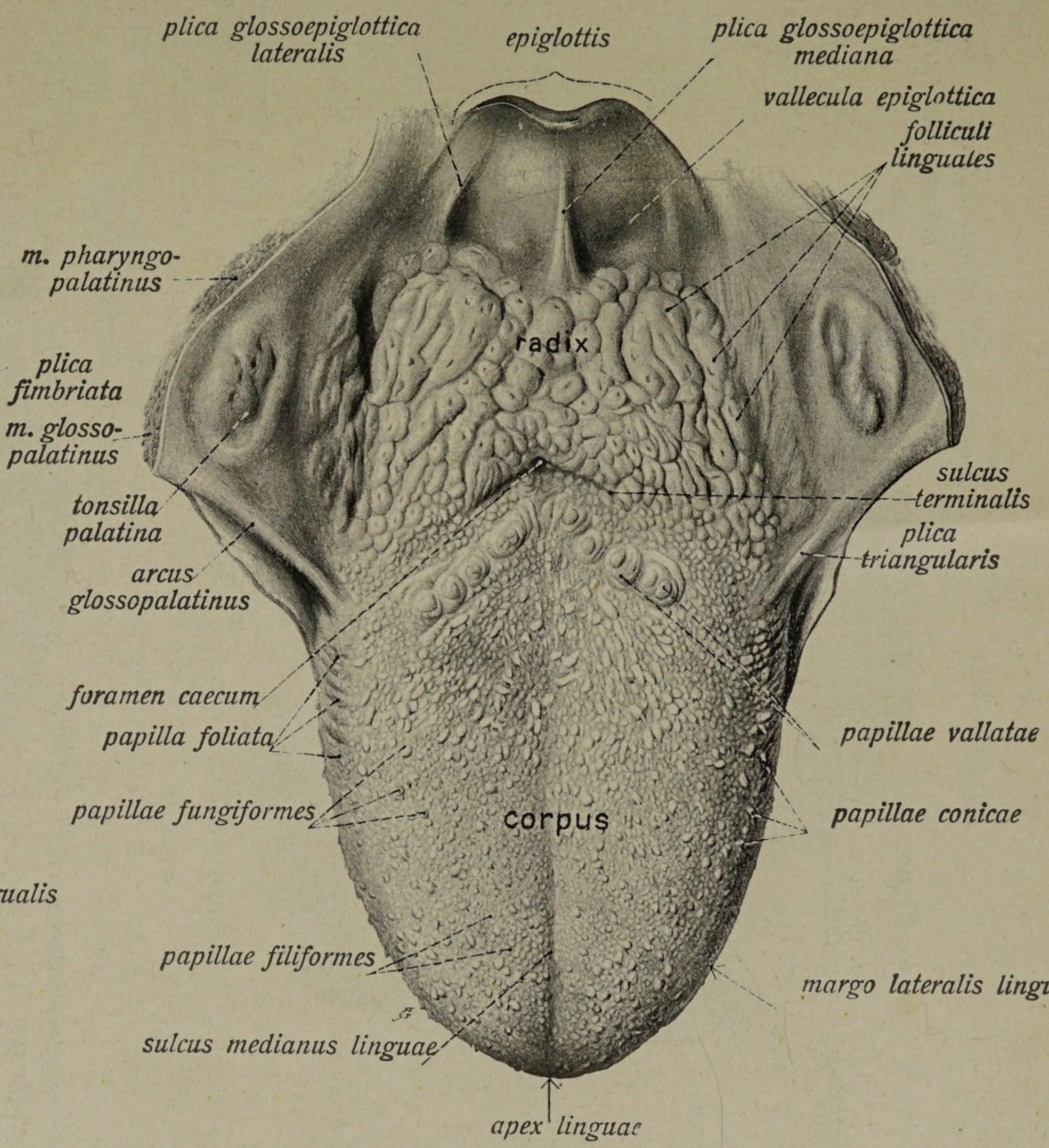


Fig. 357.

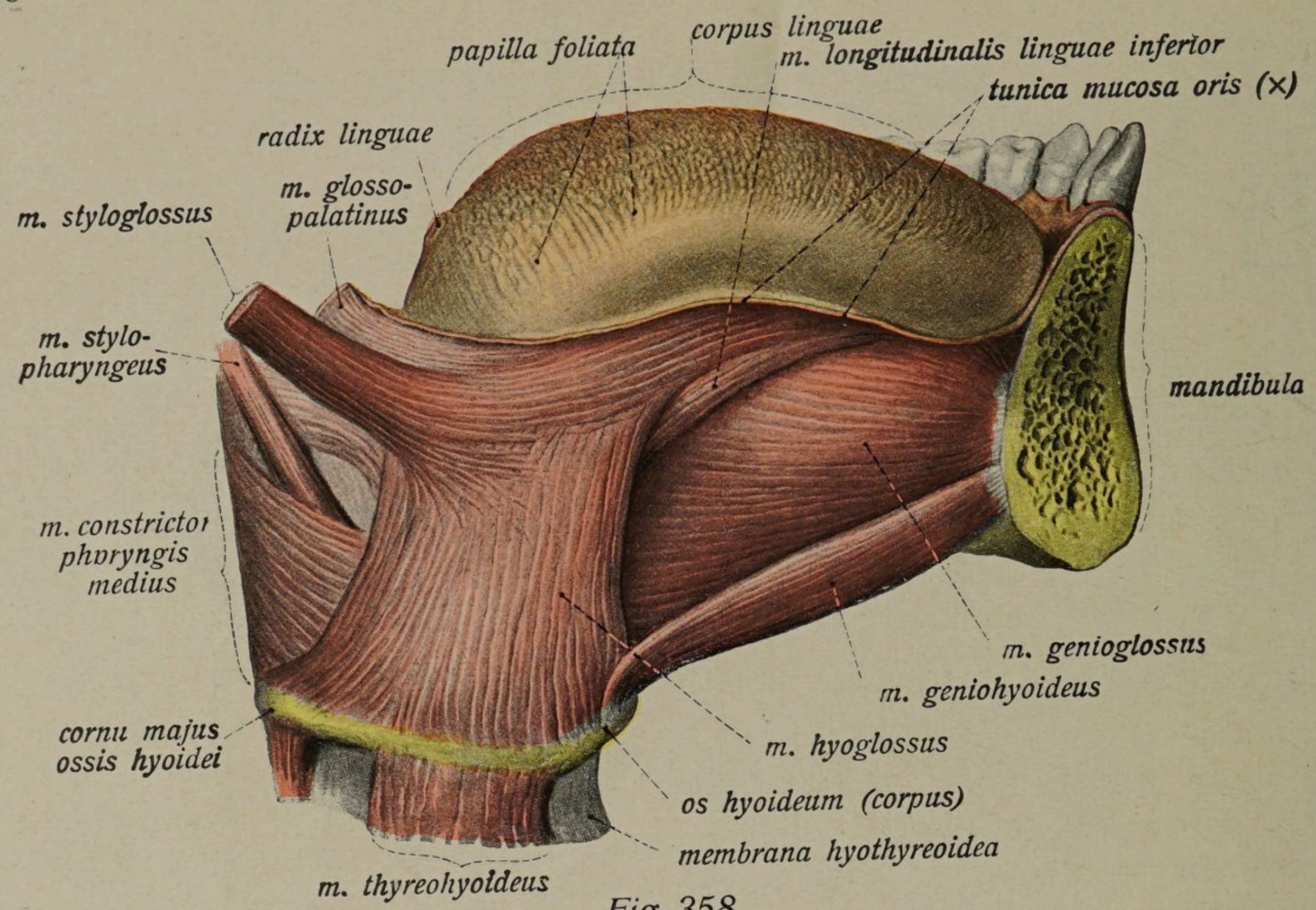


Fig. 358.

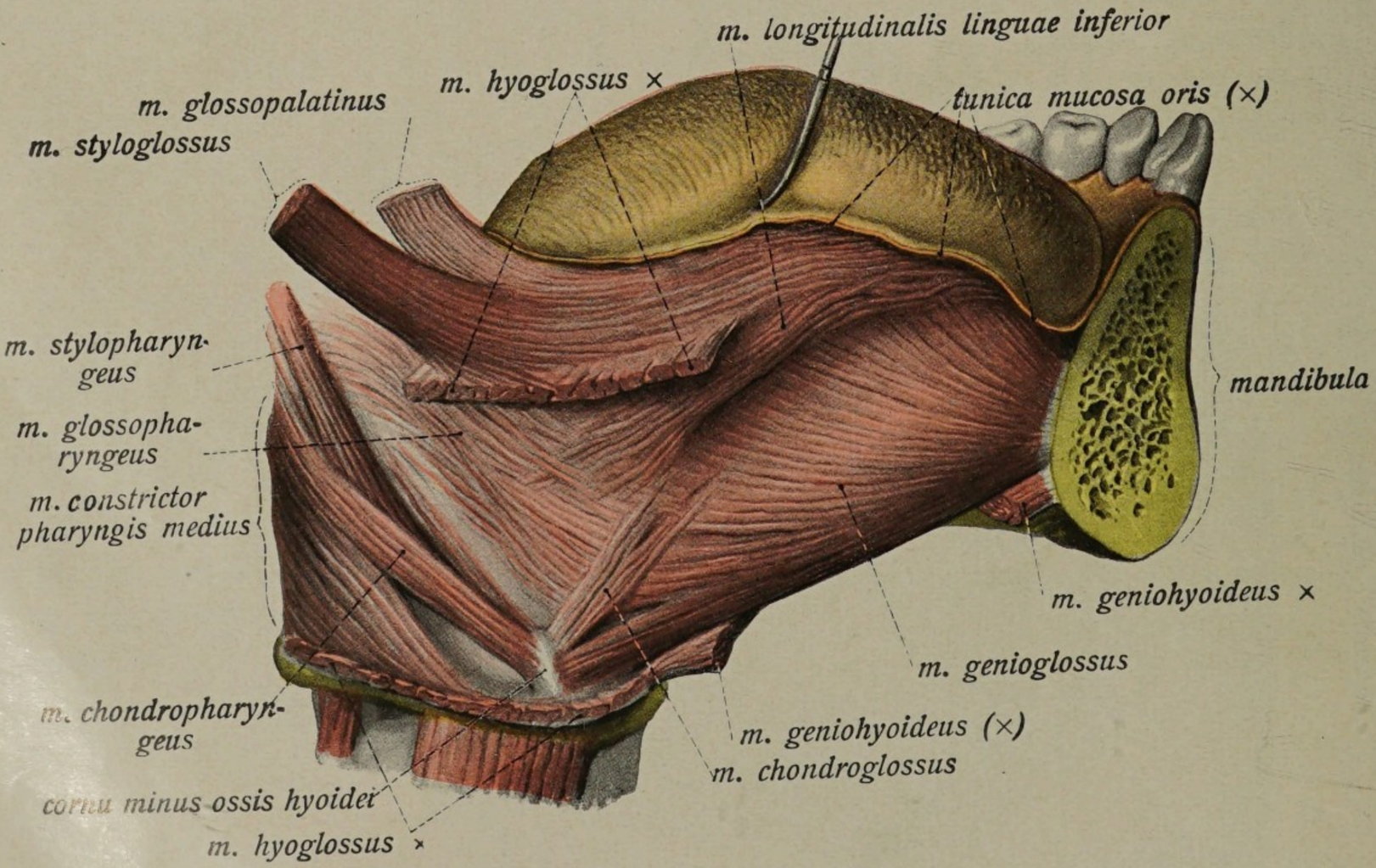


Fig. 359.

The Digestive Organs. The Tongue. (Cont.)

Fig. 358. The superficial layer of the muscles of the tongue, from the right side. ($^1/_1$)
Fig. 359. The deeper layer of the muscles of the tongue from the right side. The hypoglossus and the genio-hyoideus are cut away. ($^1/_1$)

The *papillae* of the mucous membrane of the anterior part of the tongue are in general conical; they project above the surface of the mucous membrane and give it a satiny appearance. They are divided by their form into: 1. *filiform papillae* which are thread-like, more or less cylindrical structures, and occur closely packed over the whole papillary surface and especially in its anterior and lateral portions; at their tips they have a conical, often very long epithelial thickening. 2. *Conical papillae,* which have a more conical form; they are scattered among the filiform papillae and pass over into them. 3. *Fungiform papillae* which are scattered among the filiform papillae at the side and anterior border of the tongue. Their heads are broader than their bases, they are smooth and are covered by a relatively thin epithelium,, whence they appear redder than the filiform papillae. 4. The *lenticular papillae* are merely modification of the fungiform, being somewhat lower. 5. The *vallate (circumvallate) papillae* are so-called because they are surrounded by a wall-like fold of the mucous membrane. In their outward form they resemble the fungiform, but they are larger and broader and have a constant position, forming a V-shaped figure in front of the foramen caecum (see p. 286); they are seven to twelve in number. 6. The *foliate papillae* are merely rudimentary in man. They form parallel, weakly defined, transverse folds on the lateral borders of the tongue, immediately in front of the root of the glosso-palatine arch. (Fig. 373.)

Quite different from the anterior, papillary portion of the lingual mucous membrane is the posterior tonsillar portion, characterized by the occurence in it of lymphatic *lingual follicles,* which in their sum total from the diffuse *lingual tonsil.* Each follicle is a small round elevation, with a central, fine depression. As a whole they form on the actual root of the tongue a closely packed, almost defined mass, while towards the epiglottis and the neighboring palatine tonsils they are more scattered.

The Digestive Organs. The Tongue. (Cont.)

The Muscles of the Tongue.

The muscles of the tongue consist of two groups: I. those which take origin from the skeleton (skull and hyoid bone) and end in the tongue; II. those that are entirely confined to the tongue, both their origin and insertion being in it.

Group I.

The **Genio-glossus** arises from the internal mental spine and passes mainly to the under surface of the mucous membrane of the dorsum of the tongue and partly also to the hyoid bone and the epiglottis.

The **Hyoglossus** and **Chondro-glossus** arise from the body and greater cornu of the hyoid bone (the Chondro-glossus from the lesser horn). They pass anteriorly and upwards to the lateral portions of the tongue, interlacing with the fibres of the second group.

The **Stylo-glossus** arises from the styloid process of the temporal bone and passes to the border of the tongue, interlacing with the fibres of Group II.

Group II.

The **Longitudinalis inferior** lies on the under surface of the tongue between the Genio-glossus and Hyoglossus and extends from the root to the tip; it is almost cylindrical. The **Longitudinalis superior** consists of longitudinal fibres situated at the dorsum of the tongue; they are really fibres of the Hyoglossus and Styloglossus. The **Transversus linguae** is composed of transverse fibres that pass from the septum of the tongue to the lateral surfaces; in front of the anterior end of the septum they pass from side to side, posteriorly they pass over into the Glosso-palatinus and Glosso-pharyngeus. The **Verticalis linguae** is formed by muscle bundles passing from the dorsum to the under surface of the tongue.

All the above muscles are supplied by the hypoglossal nerve.

The musculature of the tongue is incompletely divided into two halves by the fibrous *septum* of the tongue, which nowhere reaches the surface.

Fig. 360. The muscles of the tongue seen from below after separating the Genio-glossi from the mandible. On the right the Hyo-glossus is cut. ($^1/_1$)

Fig. 361. A median longitudinal section of the tongue. ($^1/_1$)

Fig. 362. Transverse section of the middle portion of the tongue. ($^5/_4$)

Fig. 363. Transverse section of the tip of the tongue. ($^5/_4$)

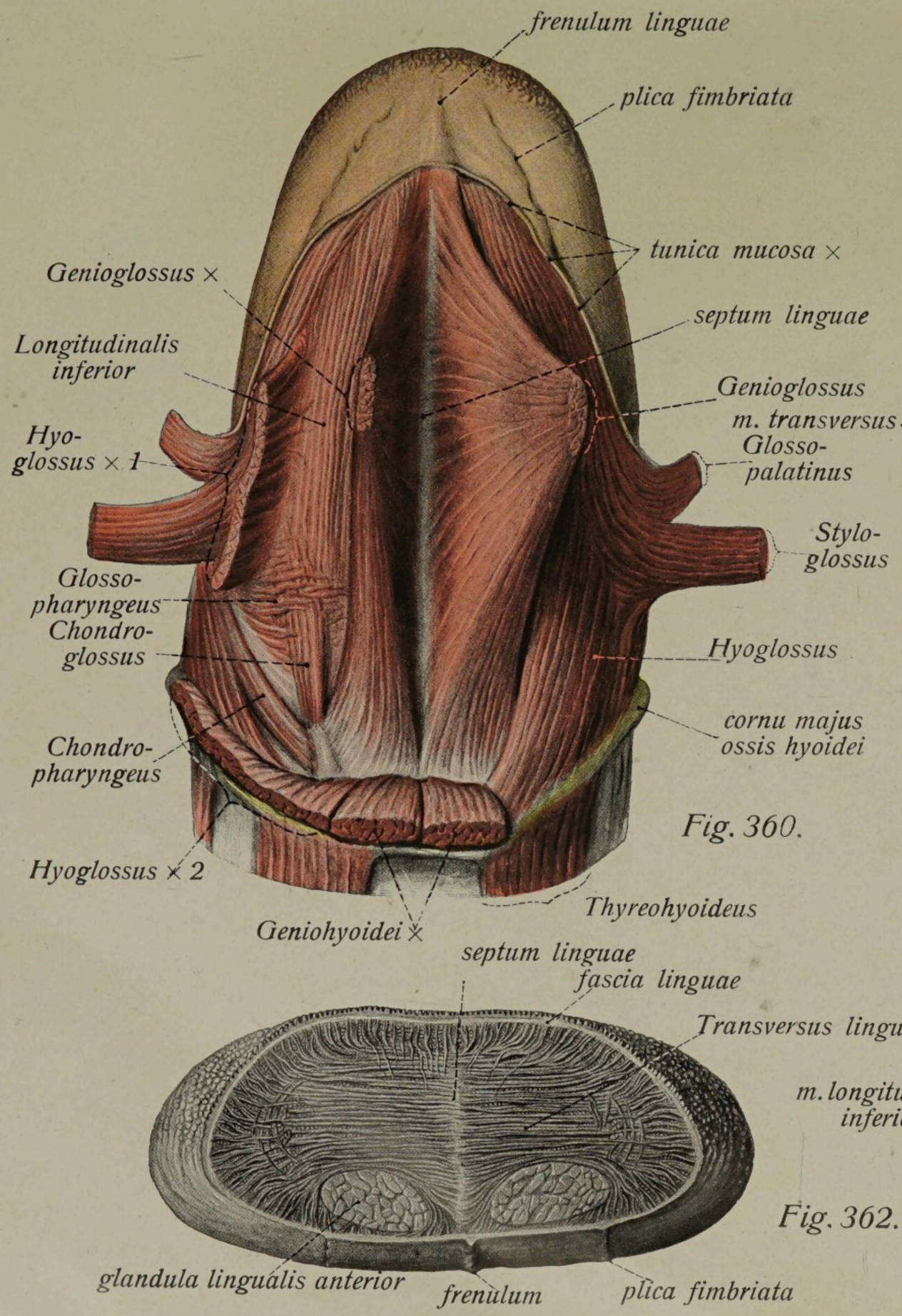


Fig. 360.

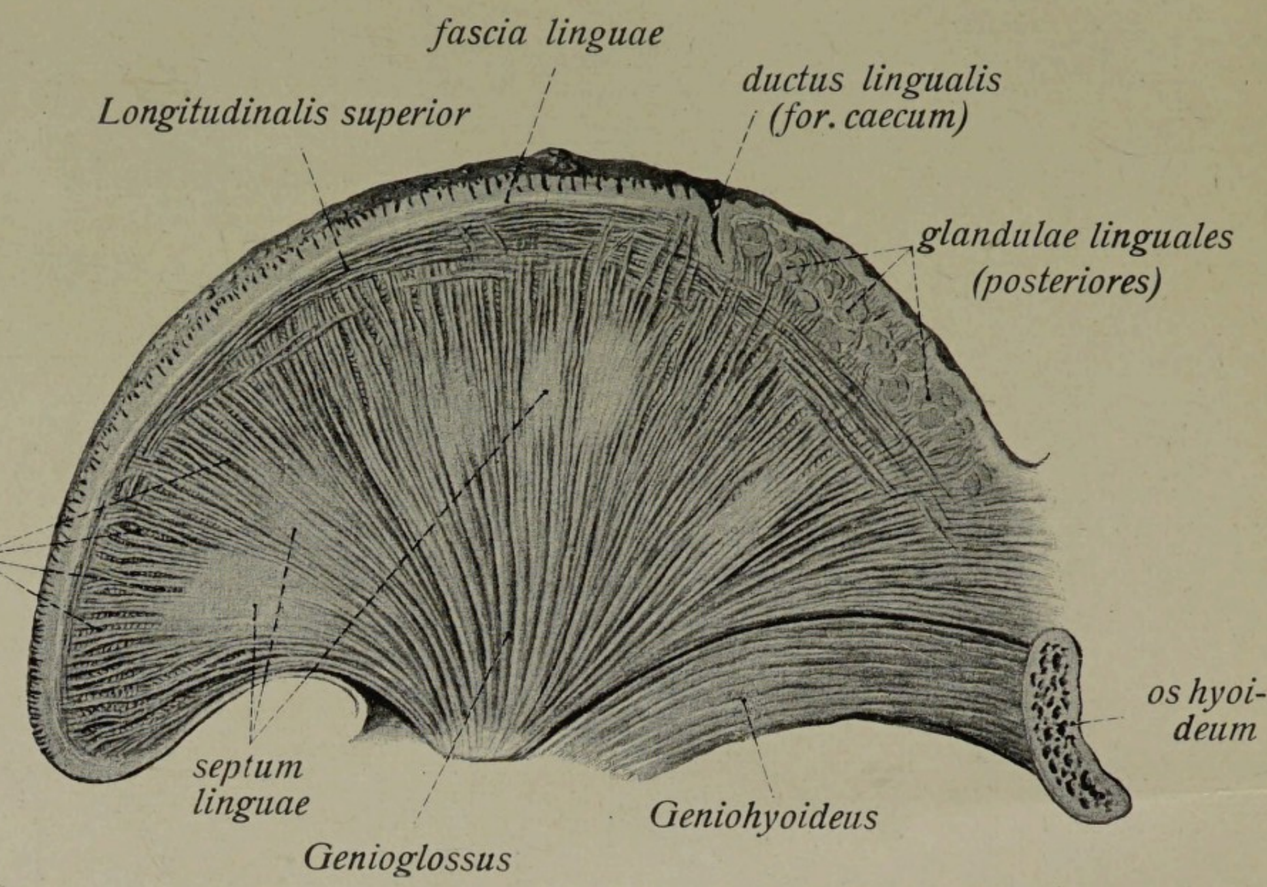


Fig. 361.

Fig. 362.

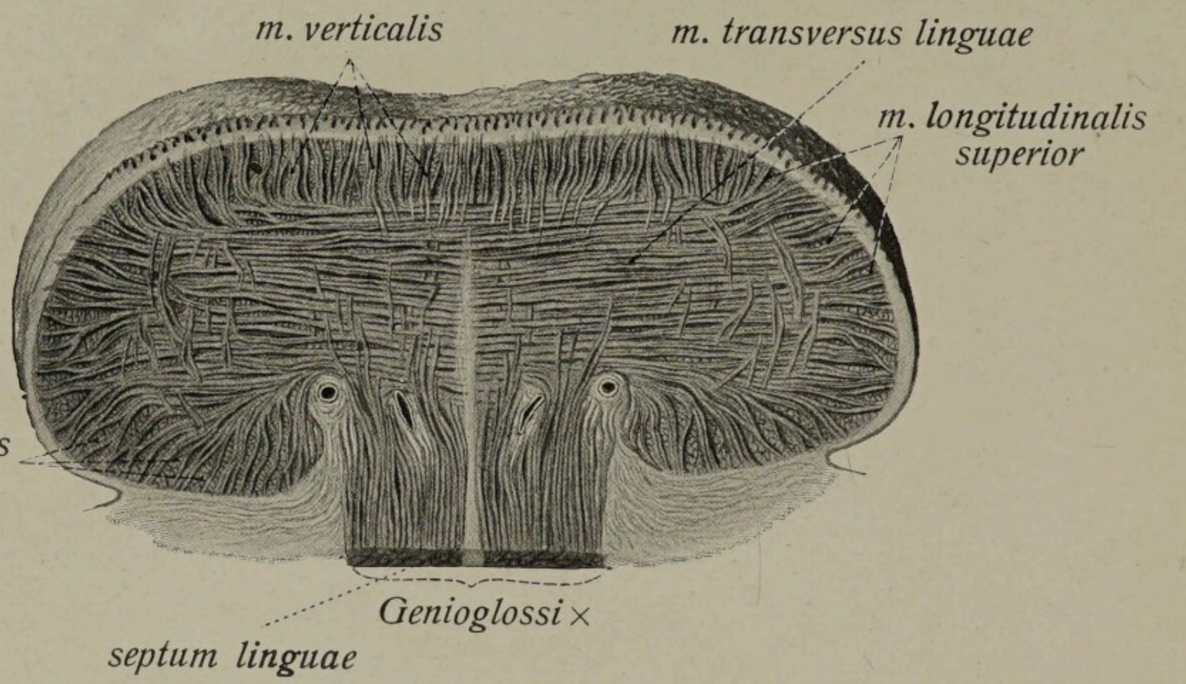


Fig. 363.

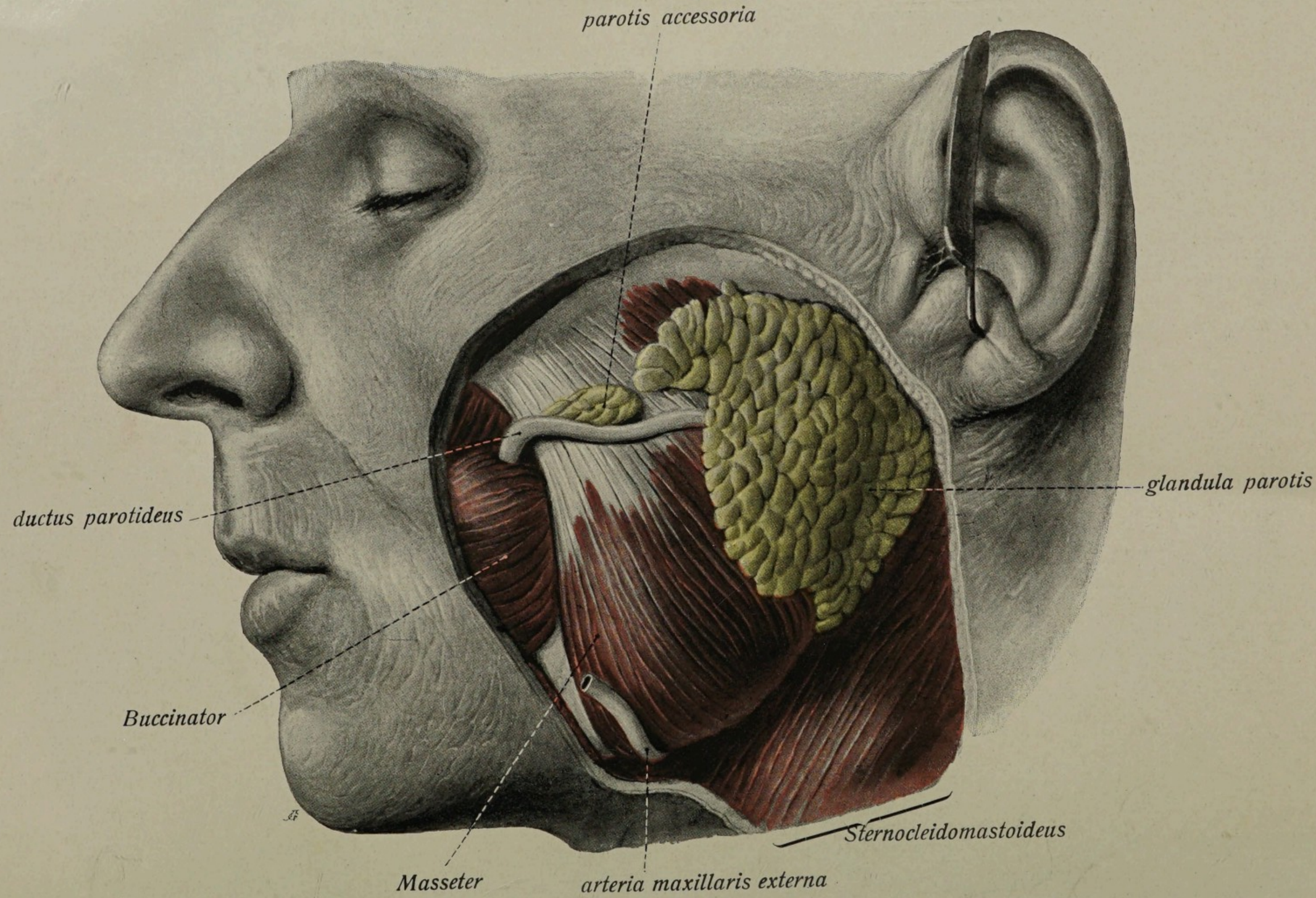

parotis accessoria
ductus parotideus
glandula parotis
Buccinator
Masseter
arteria maxillaris externa
Sternocleidomastoideus

Fig. 364.

Fig. 364. The parotid gland. The skin, platysma and fascia are removed. ($^1/_1$)

The Salivary Glands

There are two groups of glands that take part in the formation of the saliva: the numerous small glands in the walls of the mouth cavity and the three pairs of large salivary glands, the parotid, the submaxillary and the sublingual. The last form a transition to those of the first group.

The *parotid glands* are the largest of the salivary glands. They are flattened, almost triangular, but of somewhat irregular form, and are situated one on either side in front of the ear. The slightly convex, almost smooth, lateral surface is covered by the skin of the cheek, by offsets from the Platysma and by the parotideo-masseteric fascia, while its slightly concave medial surface rests principally on the Masseter, from which it is separated by a thin layer of deep fascia. The anterior part is much thinner than the posterior; the anterior border, usually rather sharp and feebly concave, lies throughout its entire length on the Masseter. The lower border is also posterior, forming an acute angle with the anterior border, a process of the gland extending downwards to the submaxillary gland and to the anterior border of the Sterno-mastoideus and thus into the retro-mandibular fossa and the submaxillary region, so that it comes to lie in the neck. The irregular upper border follows along the zygoma and the external auditory meatus. A process of the gland, the *retro-mandibular process,* extends behind the ramus of the mandible to the posterior belly of the Digastricus and the muscles that arise from the styloid process (see Fig. 369). The distinctly lobed, reddish brown gland is traversed by nerves and blood-vessels, chiefly by the branches of the facial nerve.

The *parotid duct* (Stenson's) arises above the middle of the anterior border of the gland and runs almost horizontally forward over the masseter and, shortly before reaching its anterior margin, bends medially to pass through the buccal fat pad and the Buccinator muscle to reach the mucous membrane of the mouth. It is a somewhat flattened, rather thick-walled duct about the size of a crow-quill; its oval, slit-like orifice opens into the vestibule of the mouth opposite the second upper molar tooth. Very frequently an *accessory parotid,* resembling the main gland, occurs on the parotid duct.

The Digestive Organs. Salivary Glands. (Cont.)

Fig. 365. The submaxillary gland and the submaxillary region. ($^1/_1$) The skin, platysma and the superficial layer of the cervical fascia, which forms a capsule for the gland, have been removed. The lower parts of the Masseter and of the parotid gland are visible.

Fig. 366. The submaxillary and sublingual glands seen from the medial surface. ($^1/_1$) The latter in the figure appears to be a single gland. (see Fig. 368.) The mandible is divided in the middle line and the tongue removed as is also the Genio-hyoid; the Mylohyoid is divided in the median line and the mucous membrane of the mouth drawn upwards. * = flat prolongation of the submaxillary gland that lies above the Mylohyoid.

The *submaxillary gland* is an oval, slightly flattened structure, about the size of a plum. It lies in the neck, in the submaxillary region, immediately beneath the Platysma and the superficial cervical fascia. This lies mainly below the mylohyoid muscle, filling the space between the angle of the mandible and the two bellies of the Digastricus, bordering also on the Stylo-hyoid, Stylo-glossus and partly the Hyo-glossus. It is more coarsely lobed than the parotid and is paler in color. Its upper part forms the submaxillary fovea on the mandible (see Vol. I, Fig. 94 and 95), while its main mass is below the base of that bone.

A thin, strongly flattened process of the gland extends upwards between the Internal pterygoid and Mylohyoid and anteriorly to the sublingual gland. The thin-walled *submaxillary duct* (Wharton's), about the size of a small quill, passes from the upper part of the gland above the Mylohyoid, between that muscle and the mucous membrane of the floor of the mouth, and runs forward and medially, medial to the sublingual gland, producing the *sublingual* fold, to the *sublingual caruncule* beside the frenulum of the tongue. The external maxillary (facial) artery lies in a deep groove on the upper medial surface of the gland.

The *sublingual gland* lies immediately below the mucous membrane of the floor of the mouth and is an elongated, strongly flattened structure. It is placed almost sagittally and is visible through the mucous membrane, lateral to the sublingual fold, if the tip of the tongue is raised. Its lateral border lies in the sublingual fovea of the mandible and its posterior part borders upon the submaxillary gland; and its medial border upon the Genio-glossus; its under surface rests upon the Mylohyoid. It is the smallest of the three salivary glands and is but slightly compact, being usually composed of two portions only loosely connected (see p. 299).

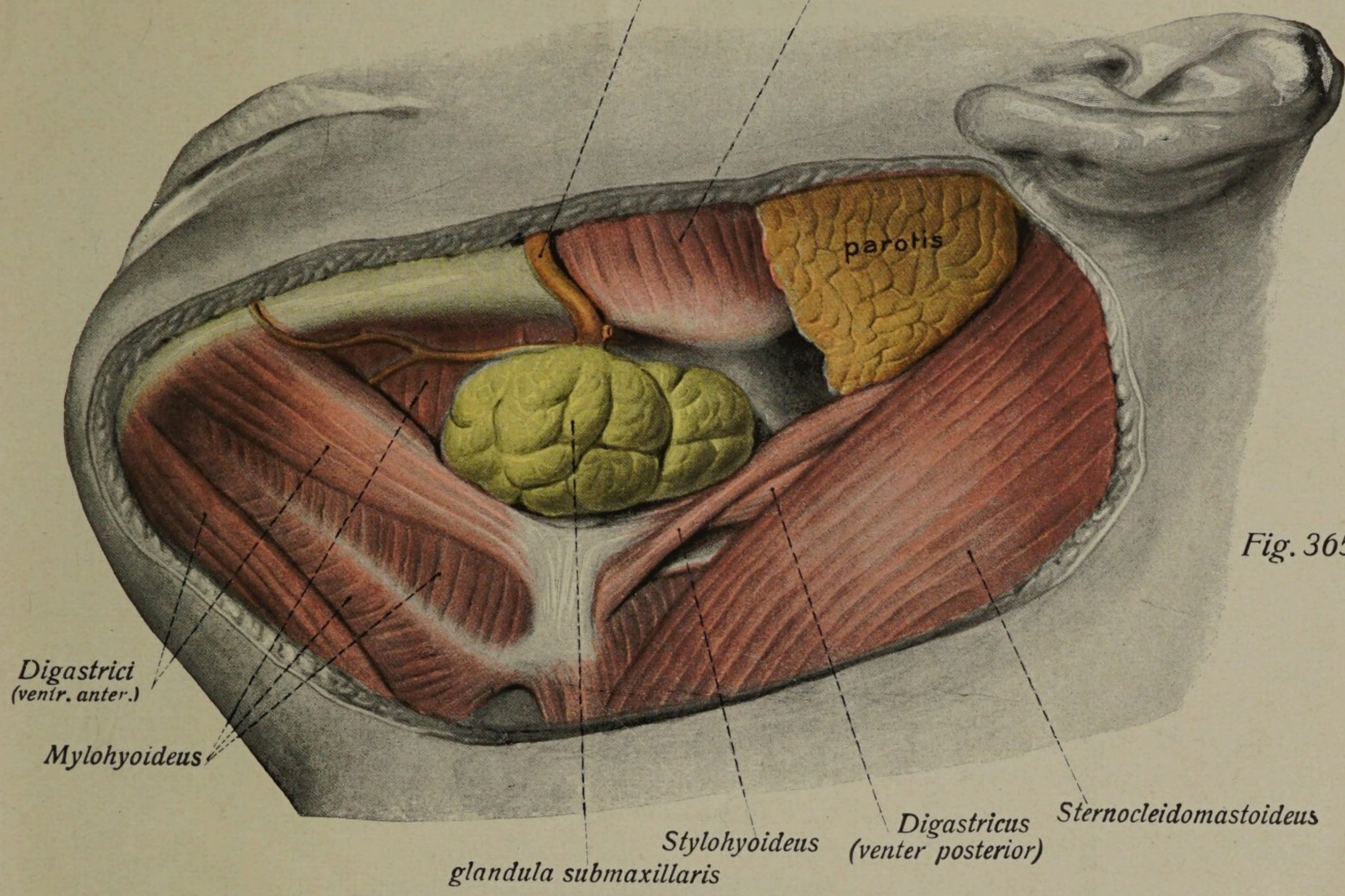


Fig. 365.

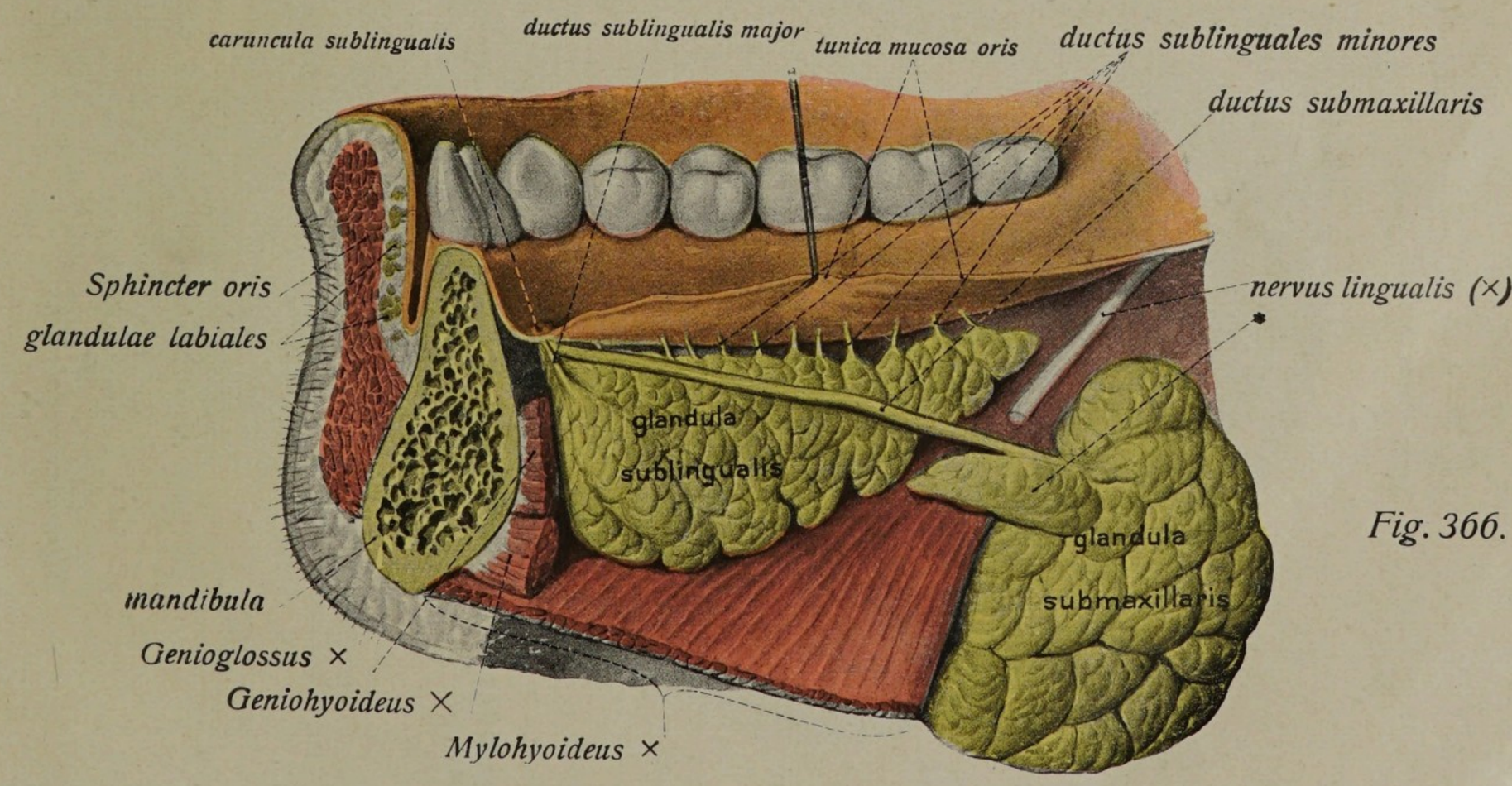


Fig. 366.

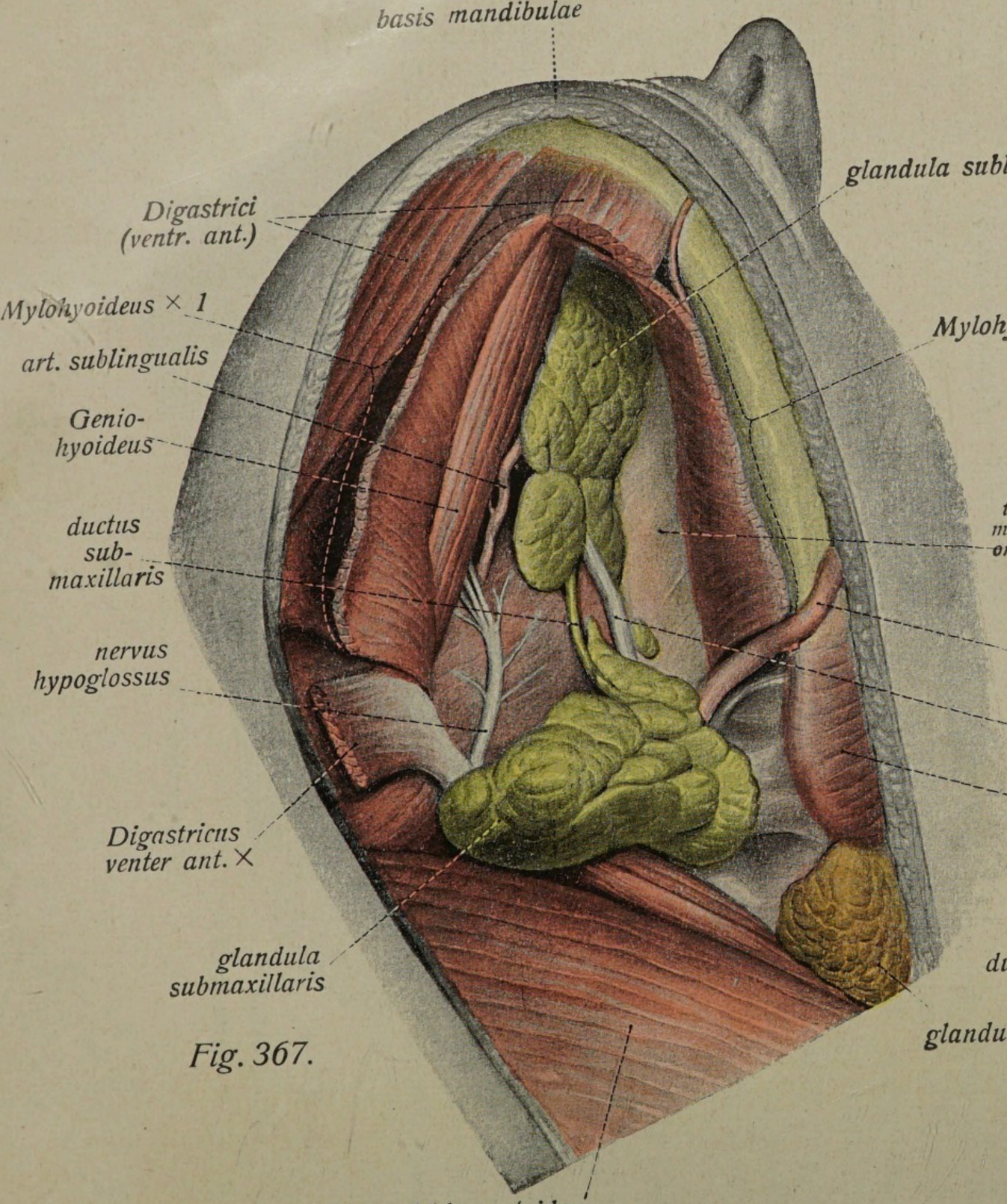


Fig. 367.

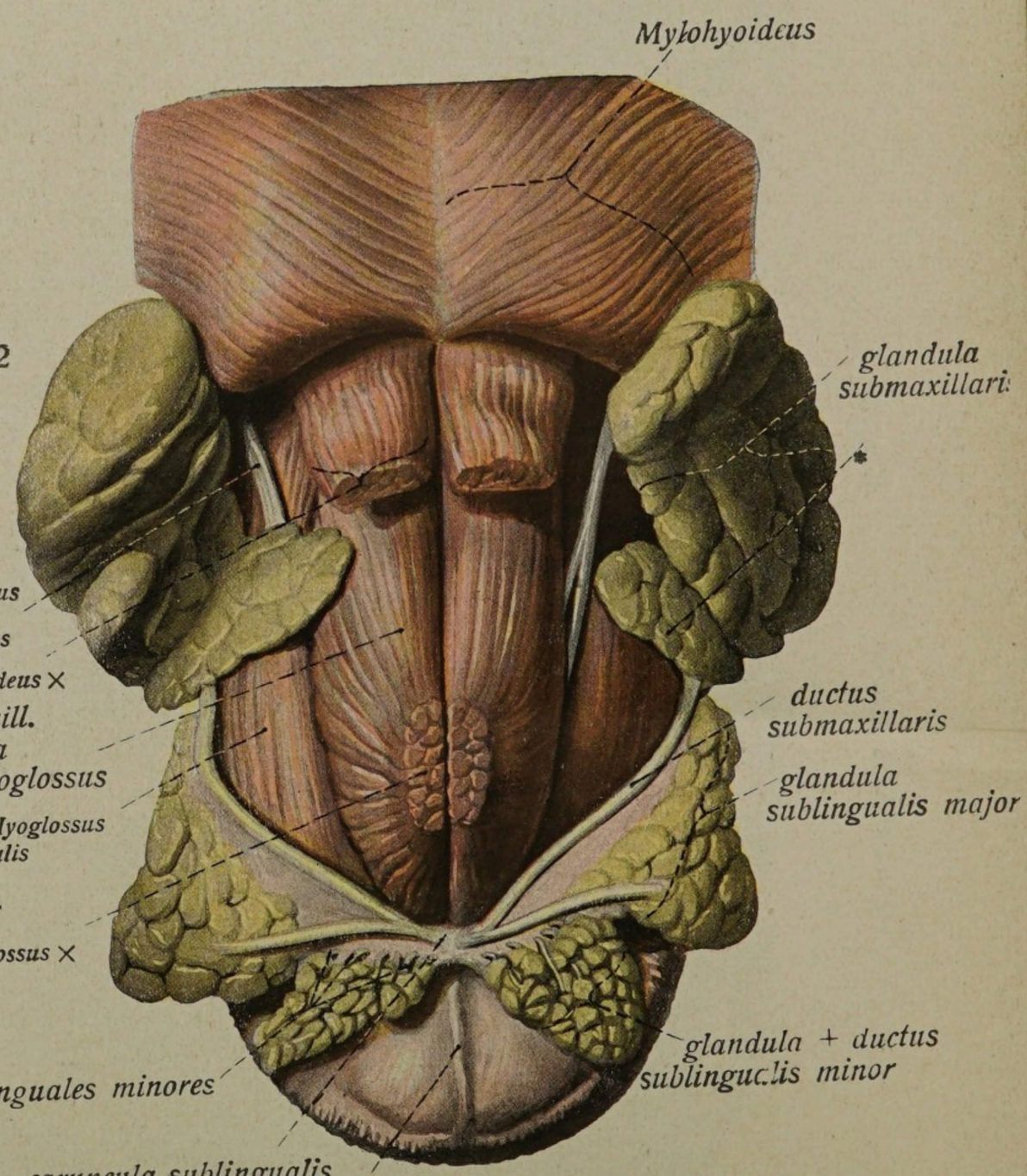


Fig. 368.

Fig. 367. The submaxillary and sublingual glands in position in the submaxillary fossa and the submental [illegible] after cutting the Mylohyoid. (1/1)

The Digestive Organs. The Salivary Glands. (Cont.)

One may recognize accordingly a large, *greater sublingual gland* and a smaller complex of glands nearer the tip of the tongue, the *lesser sublingual gland.* The former has a single duct about the thickness of a small quill, by means of which it pours its secretion into the mouth cavity at the sublingual caruncula. The lesser gland is sometimes not sharply separated from the greater and has six to twelve ducts, which open by minute openings on the anterior part of the sublingual fold. Loose connective tissue binds the two portions into an apparently single mass.

The Smaller Glands of the Mouth Cavity.

The smaller glands of the mouth cavity are:

1. The *labial glands* of the upper and lower lip, situated between the musculature and the mucous membrane.

2. The *buccal glands* of the cheeks, partly between the mucous membrane and musculature, partly between the musculature and the skin.

3. The *molar* or *retromolar glands,* scattered, small glands in the mucous membrane behind the last molar tooth.

4. The *lingual glands* beneath the mucous membrane of the dorsum of the tongue, but only in the posterior part of the papillary portion (especially in the neighborhood of the vallate and foliate papillae), that is to say, at the root of the tongue. A large one of this group, the *anterior lingual gland* (gland of Nuhn), lies in the musculature of the tip of the tongue, its duct opens on the mucous membrane of the under surface of the tongue.

5. The *palatine glands* in the mucous membrane of the hard and soft palates, in the latter partly between the musculature and the mucous membrane.

All these glands fall far short of the size of the three large salivary glands. The majority are about the size of a hempseed.

Fig. 367. The submaxillary and sublingual glands in position in the submaxillary fossa and the submental region, after cutting the Mylohyoid. ($^1/_1$)
The anterior belly of the Digastric is cut away and the submaxillary gland is drawn backward.

Fig. 368. The submaxillary and sublingual glands, greater and lesser, ($^1/_1$)
The two Mylo-hyoids have been reflected over the hyoid bone, the Genio-hyoids cut away and the Genio-glossi divided close to their origin from the mandible. The greater and lesser sublingual glands are separated to show the difference in the behavior of their ducts. (as in Fig. 366.)
* See Pg. 294 explanation of Fig. 366.

Fig. 369. The pharynx with the constrictor muscles from behind. ($^1/_1$)
The skull has been cut away by a wedge-shaped cut which passes through the occipital bone, the jugular fossa, and the mastoid process. The cervical vertebrae have been removed with the back part of the skull. * = Bundle of the Superior constrictor from the base of the skull.

The Pharynx.

The *pharynx* is an unpaired cylindrical tube, slightly flattened from before backwards and placed vertically. It is completely closed laterally and posteriorly by muscular walls and anteriorly is in open communication with the nasal and mouth cavities and, below, with the larynx. Its roof is formed by the base of the skull. The posterior wall is in contact behind with the anterior surfaces of the cervical vertebrae and it extends to a level between the sixth and seventh of these vertebrae, where it passes into the oesophagus. Like the lateral walls the posterior is formed principally by the constrictor muscles; the anterior wall has no special muscles. The Stylo-pharyngeus muscle serves to suspend it to the base of the skull.

The Constrictors of the Pharynx.

The **Superior constrictor** of the pharynx *(Cephalo-pharyngeus)* may be regarded as composed of four parts. The *Pterygo-pharyngeus* arises from the hamulus of the sphenoid; the *Bucco-pharyngeus* from the pterygo-mandibular raphe; the *Mylo-pharyngeus* from the mylo-hyoid line of the mandible; and the *Glosso-pharyngeus* from the transverse fibres of the tongue. These parts unite and interlace in the *pharyngeal raphe*.

The **Middle constrictor** *(Hyo-pharyngeus)* has two portions. The *Cerato-pharyngeus* arises from the greater cornu of the hyoid, the *Chondro-pharyngeus* from the lesser cornu. They unite to pass to the pharyngeal raphe.

The **Inferior constrictor** *(Laryngo-pharyngeus)* has also two parts. The *Thyreo-pharyngeus* arises from the oblique line of the thyreoid cartilage and the *Crico-pharyngeus* from the lateral border of the cricoid cartilage. These, too, insert into the pharyngeal raphe.

The **Stylo-pharyngeus** arises from the styloid process of the temporal and is inserted into the wall of the pharynx between the middle and superior constrictors.

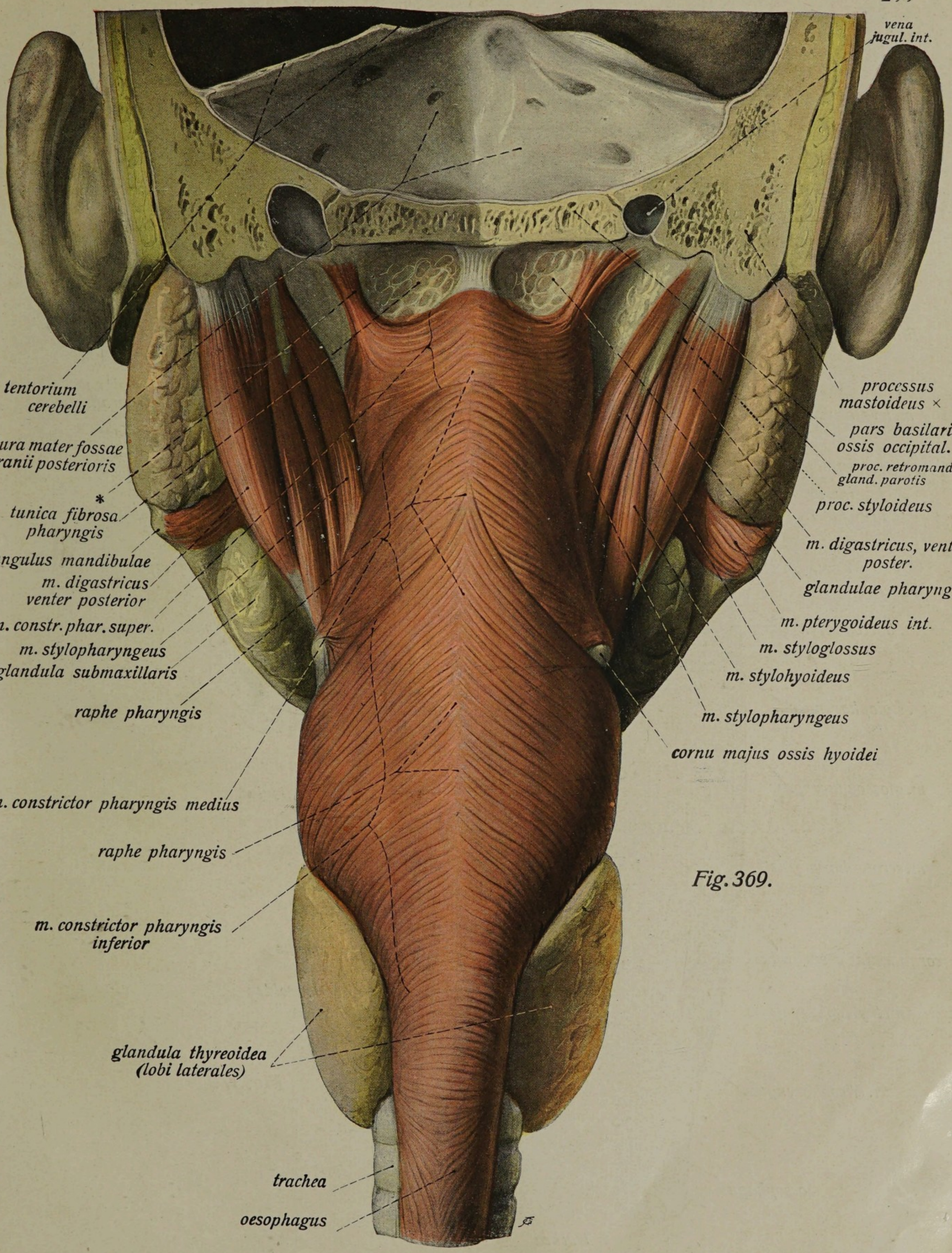

vena jugul. int.
tentorium cerebelli
dura mater fossae cranii posterioris
* tunica fibrosa pharyngis
angulus mandibulae
m. digastricus venter posterior
m. constr. phar. super.
m. stylopharyngeus
glandula submaxillaris
raphe pharyngis
m. constrictor pharyngis medius
raphe pharyngis
m. constrictor pharyngis inferior
glandula thyreoidea (lobi laterales)
trachea
oesophagus
processus mastoideus ×
pars basilaris ossis occipital.
proc. retromand. gland. parotis
proc. styloideus
m. digastricus, vent. poster.
glandulae pharyng.
m. pterygoideus int.
m. styloglossus
m. stylohyoideus
m. stylopharyngeus
cornu majus ossis hyoidei

Fig. 369.

fossa pterygopalatina
corpus maxillae
os zygomaticum ×
m. orbicularis oculi
m. nasalis
raphe pterygo-mandibularis
m. buccinator
ductus parotideus ×
m. sphincter oris
corpus mandibulae ×
mandibula
m. mylopharyngeus
m. genioglossus
m. styloglossus ×
m. geniohyoideus
m. hyoglossus
os hyoideum
m. chondropharyngeus
membrana hyothyreoidea
cartilago thyreoidea
m. cricothyreoideus
cartilagines tracheales
trachea
processus mastoideus ×
proc. zygomatic. ossis temporalis ×
tunica fibrosa pharyngis
*
m. levator veli palatini
m. tensor veli palatini
lamina lateralis proc. pterygoidei
m. pterygopharyngeus
m. buccopharyngeus
m. stylopharyngeus ×
m. glossopharyngeus
m. ceratopharyngeus
cornu majus ossis hyoidei
m. thyreopharyngeus
m. cricopharyngeus
oesophagus

Fig. 370

The Digestive Organs. The Pharynx. (Cont.)

Fig. 370. The muscular wall of the pharynx from the right side. ($^1/_1$) The hinder part of the body and the entire ramus of the mandible have been removed, as well as the mastoid process and the zygoma. The muscles of mastication and the greater part of the facial musculature is cut away, and so too the hyoid muscles, except the Genio-hyoid. The Buccinator is fully exposed and also the pterygo-mandibular raphe. * = bundle of the Superior constrictor from the base of the skull.

The upper border of the Superior constrictor is two cm. below the base of the skull, so that in the uppermost part of the posterior and lateral walls of the pharynx the fibrous coat, with the pharyngeal glands, form the outer wall of the cavity. (Fig. 369.)

The constrictor muscles of the two sides unite behind in a median *pharyngeal raphe*. They are not simply in contact with one another, but, especially in their lower part, overlap to a greater or less extent. For this reason in a view of the pharyngeal wall from behind it seems to be formed over far the greatest part by the largest of the three constrictors, the Constrictor inferior, this partly overlapping the Constrictor medius from behind, just as this overlaps the Constrictor superior. Since the muscles broaden posteriorly this arrangement is more evident from behind (Fig. 369) than in a lateral view (Fig. 370).

The Stylopharyngeus sinks into the pharynx wall between the Superior and Middle constrictors.

The constrictors are supplied by the vagus and glosso-pharyngeal nerves through the pharyngeal plexus; the Stylo-pharyngeus by a branch from the glosso-pharyngeal.

The Digestive Organs. The Pharynx. (Cont.)

Fig. 371. The cavity of the pharynx from behind, after cutting through the posterior wall in the median line. ($^1/_1$) The posterior and lateral walls are reflected, horizontal cuts having been made in their uppermost portions.

The *cavity of the pharynx* consists of three portions, one situated above the other and not distinctly separated from one another, the *nasal, oral* and *laryngeal portions*. The nasal portion communicates with the nasal cavity through the choanae and is separated from the mouth cavity by the soft palate. Its roof, which lies immediately beneath the base of the skull is termed its *fornix*. On either side, on its lateral wall opposite the opening of the inferior meatus of the nose at the choanae, is an oval opening, the *pharyngeal opening* of the *tuba auditiva* (Eustachian tube). The lips of the opening are anterior and posterior; the anterior is the larger and contains the free end of the cartilage of the tuba auditiva, which projects as a rounded swelling, the *torus tubarius*. Above and behind the torus there is on either side in the fornix of the pharynx a deep, blind sack, the *pharyngeal recess* (Rosenmüller's). Between the openings of the two tubae is an unpaired *pharyngeal tonsil,* which usually becomes rudimentary in the adult. Anterior and medial to the opening of the tuba an elevation of the mucous membrane, the levator swelling, passes obliquely downward to the soft palate (Fig. 372).

The anterior lip of the tubal opening is continued downward towards the posterior border of the hard palate as the *salpingo-palatine fold,* while the *salpingo-pharyngeal* fold extends downwards from the torus tubarius and sometimes contains a muscle of the same name.

The *oral portion* of the pharynx is in direct continuity with the mouth cavity through the isthmus of the fauces and is separated from it by the pharyngo-palatine arches. It is the narrowest part of the pharynx, but otherwise presents no marked peculiarities.

The *laryngeal portion* is separated from the oral portion by a fold, the pharyngo-epiglottic fold, which passes to the epiglottis on the lateral wall of the pharynx. The laryngeal is the only portion which has a distinct anterior wall. It lies behind the larynx, whose posterior surface is so closely associated with the mucous membrane of the pharynx that the latter shows a median elevation, corresponding to the cricoid and the arytenoid cartilages, and two lateral, deep depressions, the *piriform recesses*. In these on either side there is generally an oblique elevation, passing from above downwards and medially, the fold for the laryngeal nerve. Furthermore, the opening *(aditus)* of the larynx lies in this portion of the pharynx.

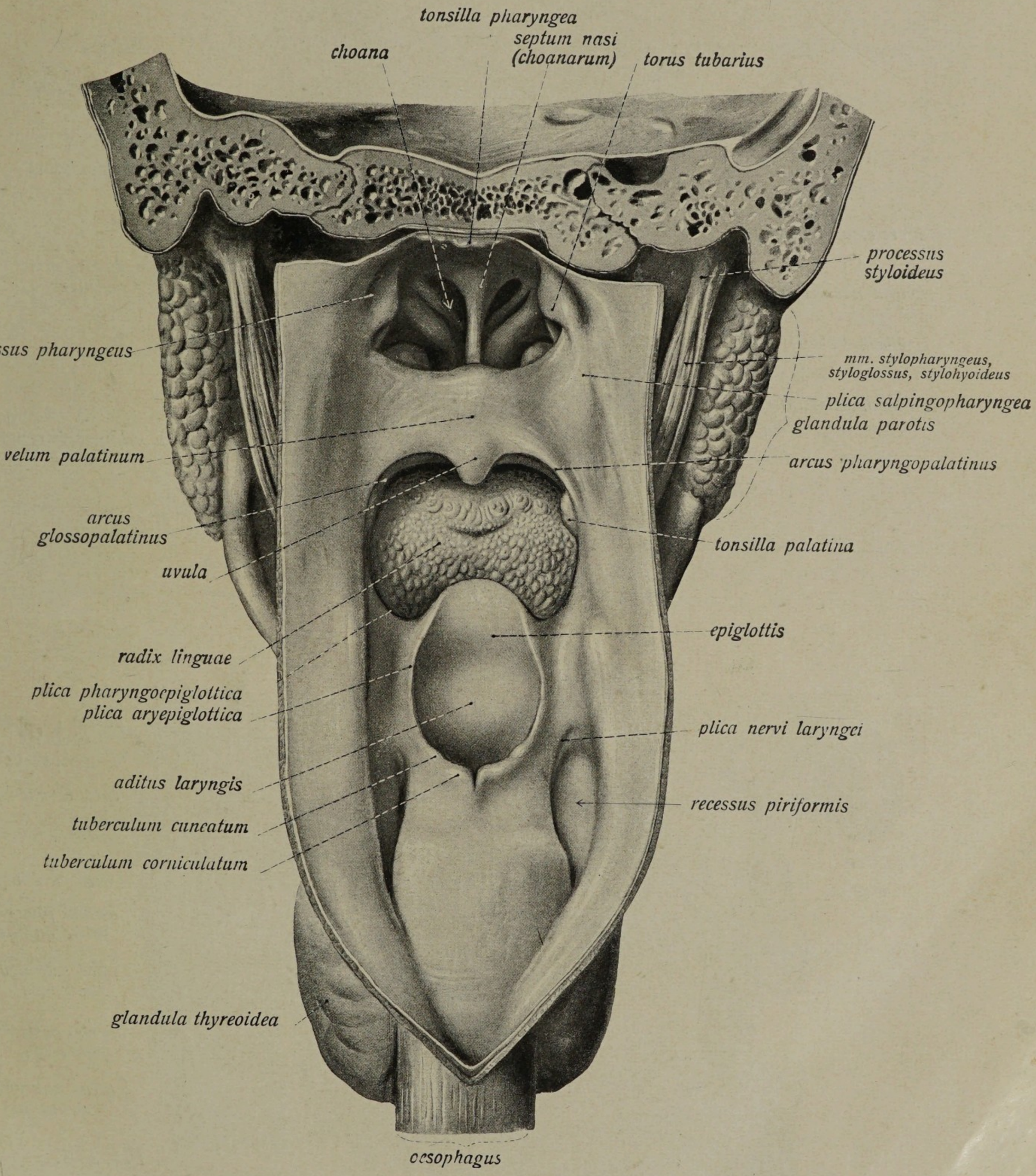

tonsilla pharyngea
septum nasi (choanarum)
choana
torus tubarius
processus styloideus
recessus pharyngeus
mm. stylopharyngeus, styloglossus, stylohyoideus
plica salpingopharyngea
glandula parotis
velum palatinum
arcus pharyngopalatinus
arcus glossopalatinus
tonsilla palatina
uvula
epiglottis
radix linguae
plica pharyngoepiglottica
plica aryepiglottica
plica nervi laryngei
aditus laryngis
recessus piriformis
tuberculum cuneatum
tuberculum corniculatum
glandula thyreoidea
oesophagus

Fig. 371.

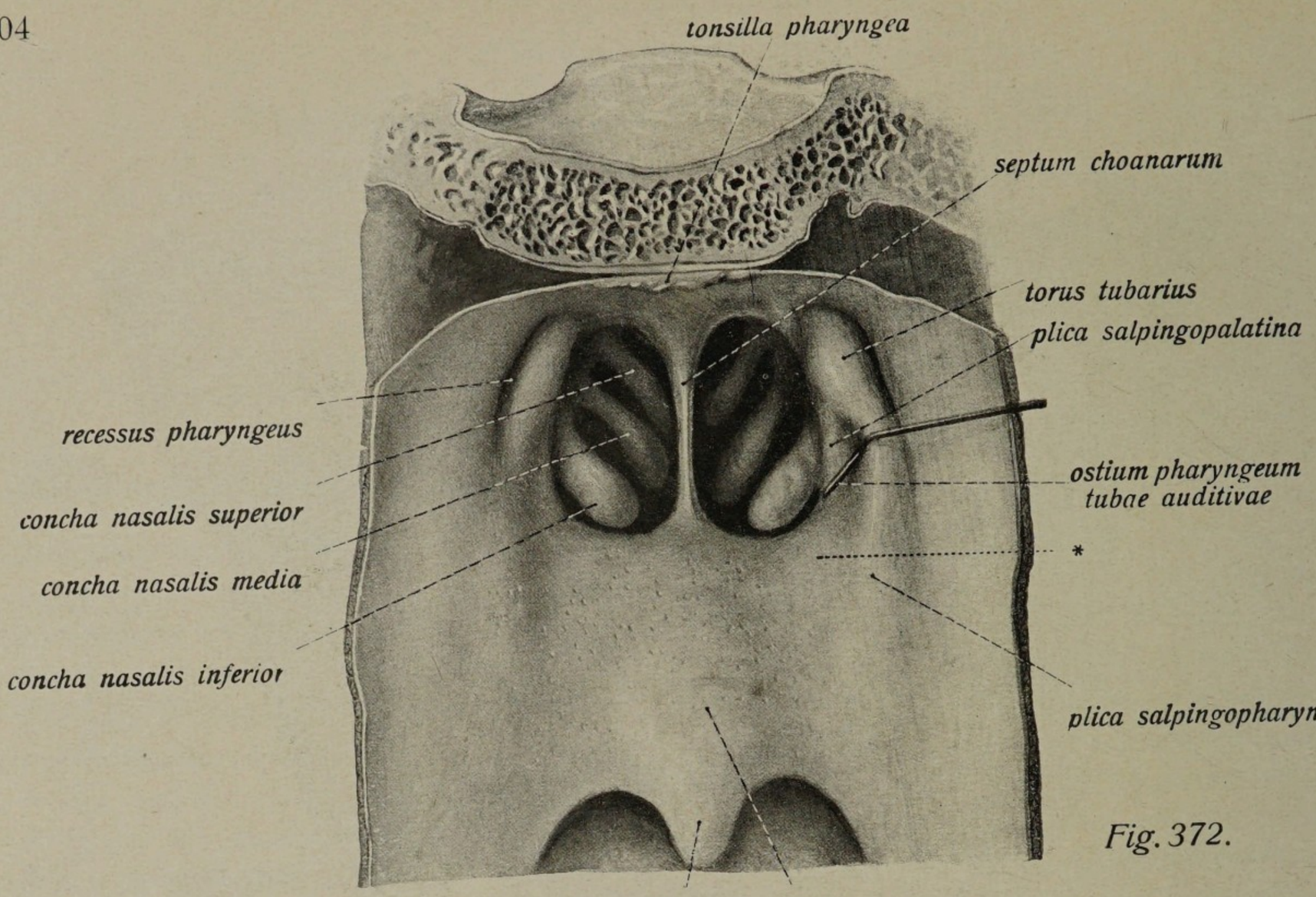


Fig. 372.

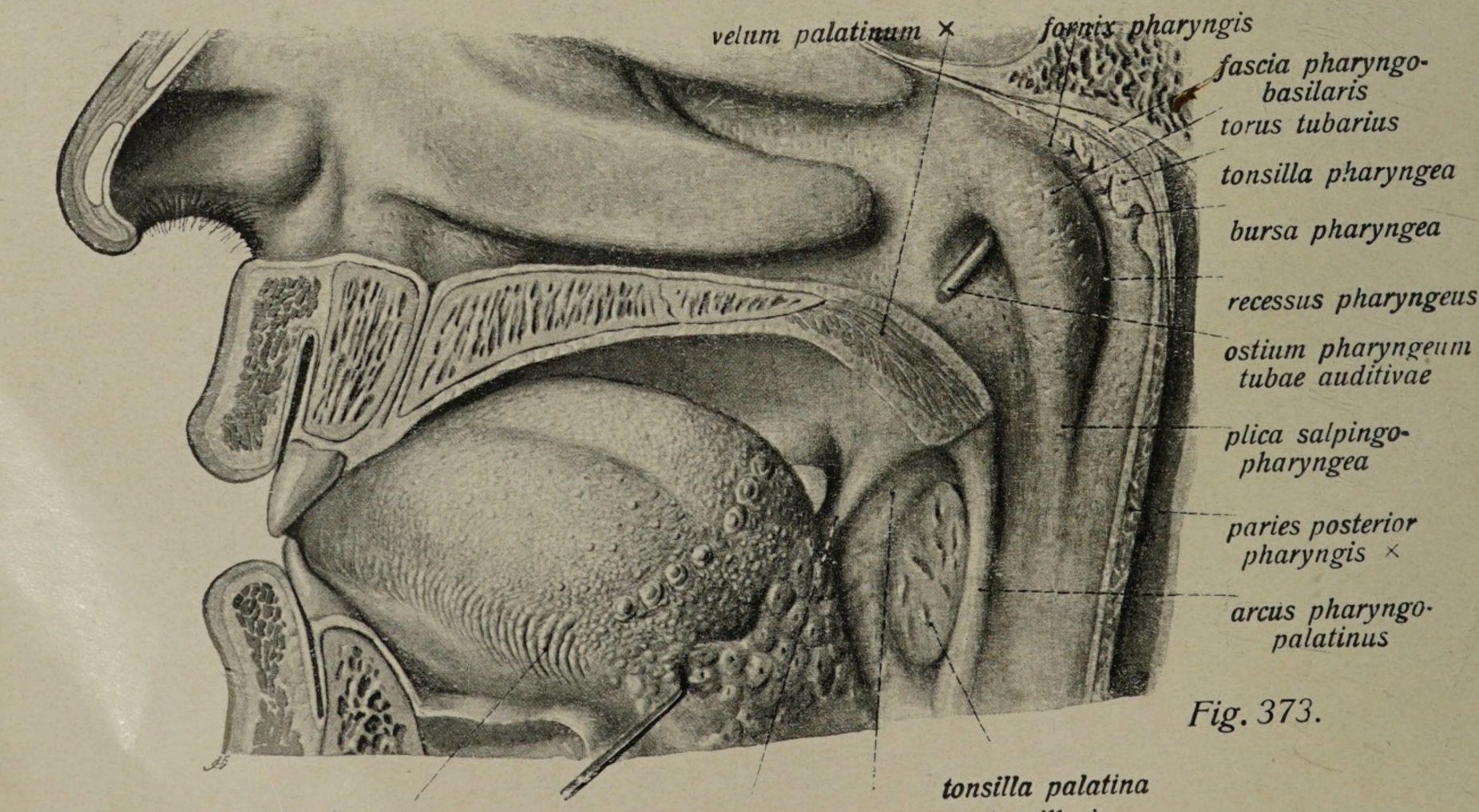


Fig. 373.

The Digestive Organs. The Pharynx, Palatine Arches and Tonsil.

Fig. 372. The nasal portion of the pharynx, from behind, after cutting through its posterior wall in the median line. ($^1/_1$) * = the levator swelling.

Fig. 373. The nasal portion of the pharynx, the palatine tonsil and the palatine arches. ($^1/_1$) The skull is divided close to the median line and the tongue is drawn a little forward and the uvula is cut away.

The wall of the pharynx consists of a mucous membrane, a fibrous coat and a muscular coat. The reddish, rather smooth and thin mucous membrane contains in its upper part small mucous *pharyngeal glands*. The fibrous coat in the uppermost part of the pharyngeal wall, where the muscular coat is lacking for an extent of about two cm., forms a strong membrane, the *pharyngo-basilar fascia,* which is attached above to the skull. The muscular coat occurs upon the lateral and posterior surfaces, except in their uppermost parts; it consists essentially of circular fibres, the *constrictors of the pharynx.* (See Fig. 369—370) which unite and partly interlace posteriorly in a median *raphe* (p. 301).

In addition there are other muscles in the pharyngeal wall, which at the same time belong to the soft palate, since the posterior surface of this forms at the same time the anterior wall of the nasal portion of the pharynx (see p. 307, Fig. 374).

The Palatine Tonsil and the Palatine Arches.

The anterior *glosso-palatine arch* runs from the lateral, lower border of the soft palate to the mucous membrane of the border of the tongue, where it ends as the *triangular fold.* The posterior *pharyngo-palatine arch* is thicker than the anterior, but less strongly arched; it passes from the soft palate to the lateral wall of the oral portion of the pharynx. Between these two arches is a niche, the *sinus tonsillaris,* in which is situated the *palatine tonsil.* This is an oval elevation, usually without clearly defined boundaries but with deep clefts and fossae on its surface. It frequently does not completely fill the space between the two palatine arches, a deep depression, the *supratonsillar fossa,* lying above it. It is often continuous with the neighboring lingual tonsil, completing the lymphatic pharyngeal ring.

The Digestive Organs, the Soft Palate, Isthmus of the Fauces and Pharynx.

Fig. 374. The muscles of the soft palate and of the isthmus of the fauces from behind, the wall of the pharynx being divided posteriorly. ($^1/_1$)

The preparation is similar to that of Fig. 369 and 371. After removing the mucous membrane of the pharynx the Levator veli palatini is exposed on the left; on the right it is cut away to show the tensor and the torus tubarius is cut away showing the cut cartilaginous part of the tuba auditiva. On the right the posterior belly of the Digastricus, the Stylo-pharyngeus and Stylo-glossus are cut and on the left the mucous membrane of the anterior pharyngeal wall is partly removed to show the posterior muscles of the larynx.

The Muscles of the Soft Palate and Isthmus of the Fauces.

These muscles lie partly in the soft palate and serve for its movement (closing off the nasal from the oral portion of the pharynx) as well as for the opening of the cleft-like lumen of the tuba auditiva (Eustachian tube). They are also partly muscles of the isthmus of the fauces, which they may contract. Both groups spread out in the muscular wall of the pharynx.

The **musculus (azygos) uvulae,** usually unpaired, arises from the posterior nasal spine and passes to the uvula.

The **Lavator veli palatini** arises from the lower surface of the petrous portion of the temporal and from the cartilage of the tuba auditiva (Eustachian tube). The muscles of either side interlace in the soft palate.

The **Tensor veli palatini** arises from the angular spine and scaphoid fossa of the sphenoid and from the lateral surface of the cartilage of the tuba auditiva. Its flat tendon passes over the hamular groove and expands to form with the muscle of the other side a membranous sheet, the palatine aponeurosis, in the substance of the soft palate.

The **Glosso-palatinus (Palato-glossus)** is formed from the transverse fibres of the tongue. It passes down in the arch of the same name to the soft palate.

The **Pharyngo-palatinus (Palato-pharyngeus)** is formed from the middle and inferior constrictors of the pharynx. It passes upward in the arch of the same name to the soft palate.

The musculus uvulae, Levator, Glosso-palatinus and Pharyngo-palatinus are supplied by branches of the vagus and glosso-pharyngeal nerves, through the pharyngeal plexus. The Tensor is supplied by a branch from the mandibular division of the trigeminus that passes through the otic ganglion.

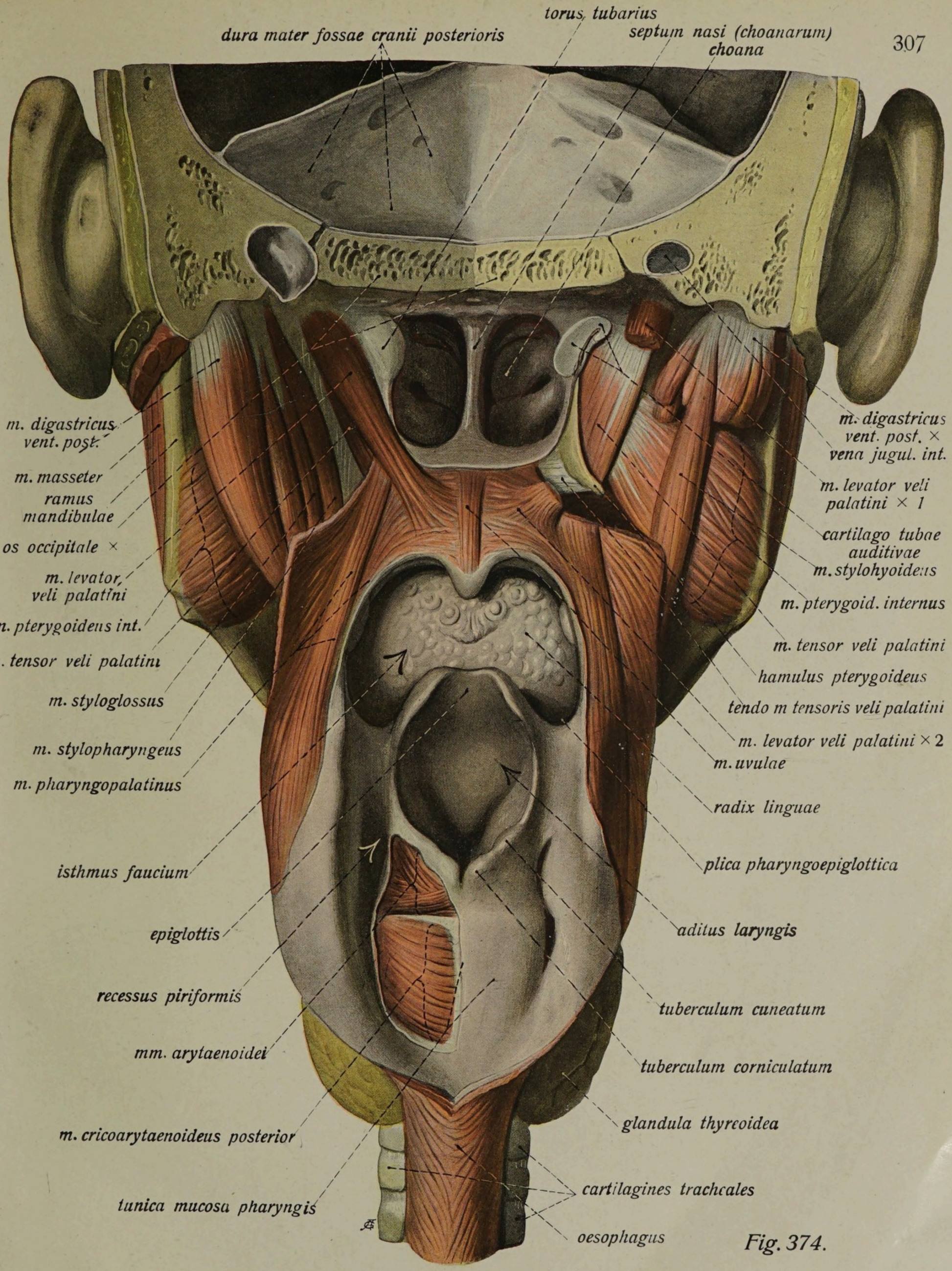

dura mater fossae cranii posterioris
torus tubarius
septum nasi (choanarum)
choana
m. digastricus vent. post.
m. masseter
ramus mandibulae
os occipitale ×
m. levator veli palatini
m. pterygoideus int.
m. tensor veli palatini
m. styloglossus
m. stylopharyngeus
m. pharyngopalatinus
isthmus faucium
epiglottis
recessus piriformis
mm. arytaenoidei
m. cricoarytaenoideus posterior
tunica mucosa pharyngis
m. digastricus vent. post. × vena jugul. int.
m. levator veli palatini × 1
cartilago tubae auditivae
m. stylohyoideus
m. pterygoid. internus
m. tensor veli palatini
hamulus pterygoideus
tendo m tensoris veli palatini
m. levator veli palatini × 2
m. uvulae
radix linguae
plica pharyngoepiglottica
aditus laryngis
tuberculum cuneatum
tuberculum corniculatum
glandula thyreoidea
cartilagines trachcales
oesophagus

Fig. 374.

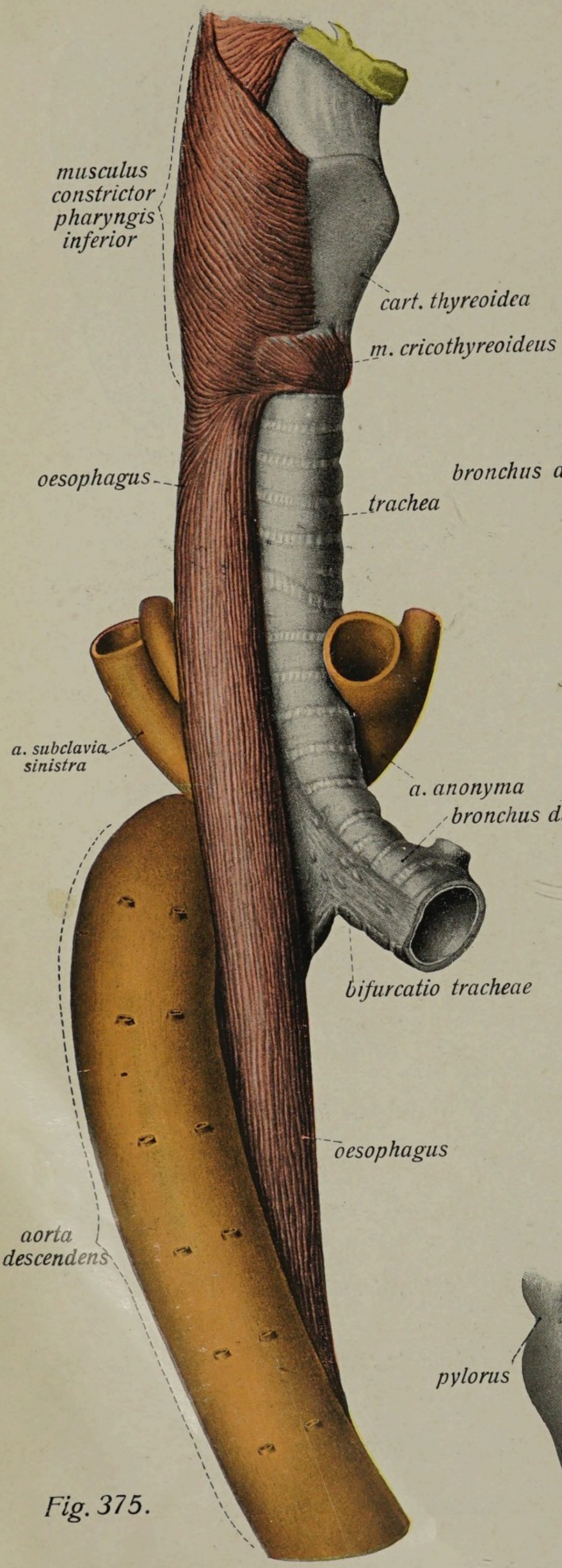


Fig. 375.

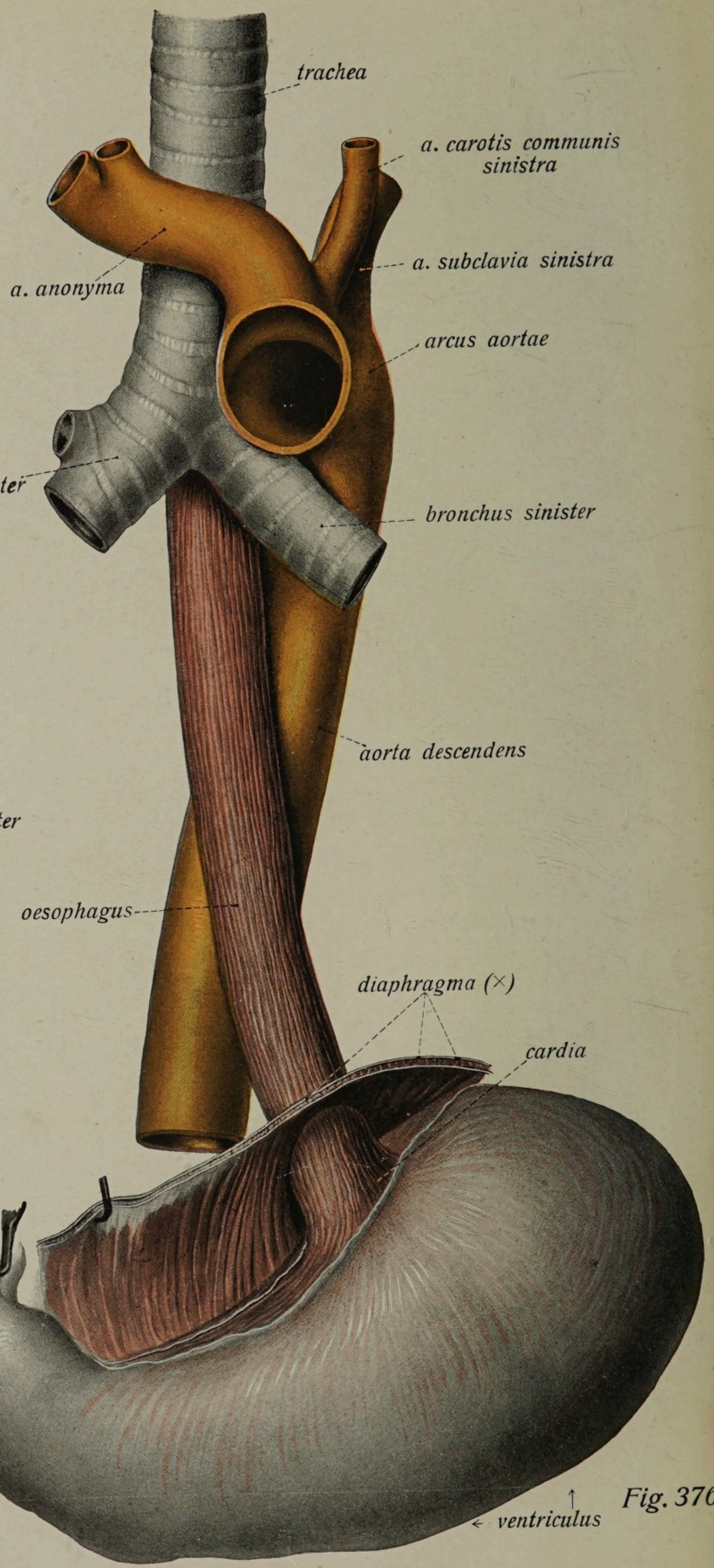


Fig. 376.

The Digestive Organs. The Oesophagus.

Fig. 375. The upper portion of the oesophagus with the aorta and its branches and the trachea, from the right side. ($^3/_4$)

Fig. 376. The lower portion of the oesophagus and the stomach with the aorta and a part of the diaphragm. ($^3/_4$) The diaphragm and pylorus of the stomach are drawn upward; the stomach is rather strongly contracted. The superficial muscle bundles are seen through the serous coat.

The Oesophagus.

The *oesophagus* is a muscular tube, about 25 cm in length, which when empty has a flattened cylindrical form. It is the continuation downward of the lower part of the pharynx and passes to the cardiac portion of the stomach. It may be divided into *cervical, thoracic* and *abdominal* parts. The *cervical part* lies at first behind the larynx and immediately in front of the cervical vertebrae, but quickly shows a slight inclination to the left, so that its lower portion is distinctly to the left of the trachea. The *thoracic part* lies at first in the superior mediastinum in front of the bodies of the thoracic vertebrae and almost in the median line, but at the bifurcation of the trachea it lies more under the origin of the left bronchus. Below this the oesophagus enters the posterior mediastinum and is in relation to the posterior wall of the pericardium and the descending aorta, which lies to the left of it, both being for a short distance almost parallel. Gradually, however, the oesophagus passes more and more to the left and in front of the aorta, which thus separates it from the bodies of the vertebrae, and later it passes very obliquely across the front of the aorta and comes to lie to the left of the median line. In general it may be said that the course of the oesophagus is practically in the median line until shortly before its passage through the diaphragm.

The *abdominal* part is only about 1 cm in length. In passing the oesophageal opening of the diaphragm, the oesophagus rather suddenly inclines to the left and opens into the stomach at the level of the eleventh thoracic vertebra. The caliber of the oesophagus is not constant throughout its length, narrower and wider portions alternating with one another. The narrowest parts are: 1. at its commencement, opposite the cricoid cartilage; 2. behind the bifurcation of the trachea; 3. where it perforates the diaphragm. In the empty state the variations in caliber are hardly noticeable.

The walls of the oesophagus consist of three layers: 1. the *inner mucous membrane;* 2. the loose *submucous coat* and 3. the outer *muscular coat,* consisting of inner circular and outer longitudinal muscle fibres. The outer and inner coats are completely separated by the intervening looser submucosa. The outer longitudinal muscle layer produces a distinctly striated appearance in the outer surface of the organ, except above where circular fibres predominate.

Except in the abdominal part, which receives a serous investment from the peritoneum, the oesophagus is imbedded in loose adventitious connective-tissue.

From the muscular coat bundles occasionally pass to the mediastinal pleura that invests the oesophagus *(m. pleuro-oesophageus),* and to the posterior wall of the left bronchus *(m. broncho-oesophageus).*

The Digestive Organs. The Stomach, ventriculus.

Fig. 378. The stomach with its peritoneal covering, from in front. ($^3/_4$)
Fig. 379. A portion of the mucous membrane of the stomach (dry preparation). ($^{18}/_1$)
Fig. 380. A portion of the mucous membrane of the small intestine (dry preparation. ($^{18}/_1$)

The stomach *(ventriculus)* is a sack-like, pear-shaped enlargement of the digestive tract, interposed between the oesophagus and the intestine. The region where the oesophagus opens into it is termed the *cardia,* the passage to the intestine on the right is the *pylorus*. In the empty stomach an *anterior* and a *posterior wall* may be distinguished, both being convex and separated by the borders or curvatures of the stomach. Of these the *greater curvature* is almost three times as long as the *lesser curvature;* the former looks upwards, laterally and downwards and is throughout convex, the lesser curvature, on the other hand, is concave (except in the pyloric region) and looks medially (upwards in the pyloric region.) At the lesser curvature the peritoneum is attached to the stomach as the lesser omentum and at the greater curvature it leaves it as the greater omentum. Three principal portions may be distinguished in the stomach, a *fundus,* a *body (corpus)* and a *pyloric portion;* the cavity of the last is termed the *pyloric antrum,* or, better, the *pyloric canal.*

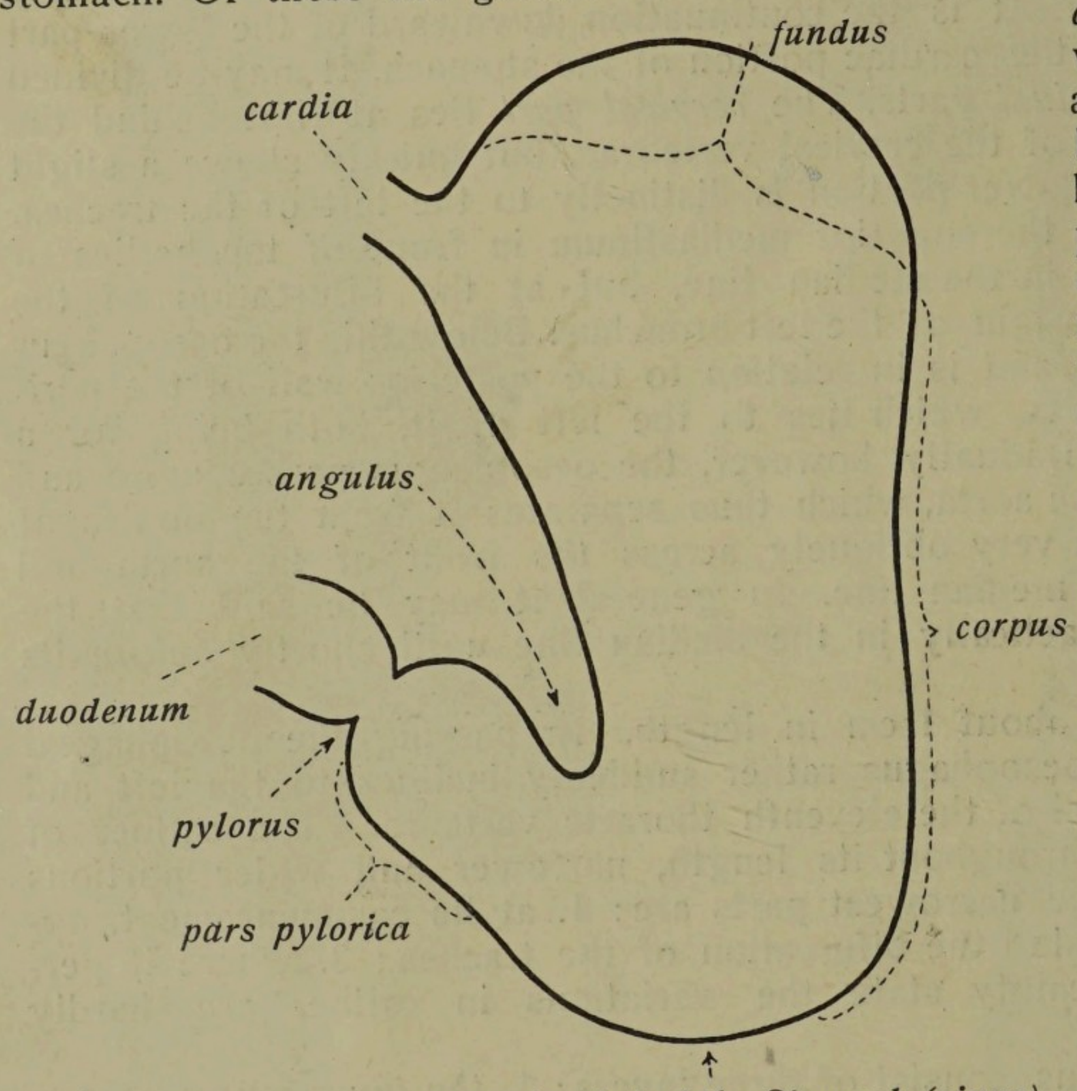


Fig. 377. The form and position of the stomach as shown during life by Roentgen rays (schematic).

The body is the principal portion of the stomach and, especially in the living, has an almost vertical position (in the atonic condition in the cadaver it is more or less transverse); in it is the lowest point of the stomach (also termed the sinus). That portion of the stomach that is uppermost and to the left is the fundus; it is in contact with the left dome of the diaphragm and the lesser curvature is not continued upon it. The body and fundus (constituting about $^5/_6$ of the entire or organ) are on the left side of the body. The pyloric portion is notably less in caliber than the rest of the stomach; in the living it is separated from the body of the stomach by a sharp angle (angulus ventriculi) and is the only portion of the organ that lies to the right of the median line. In this region the musculature of the stomach wall is especially strong. Usually the pyloric portion is directed distinctly upwards and so approximates the cardia.

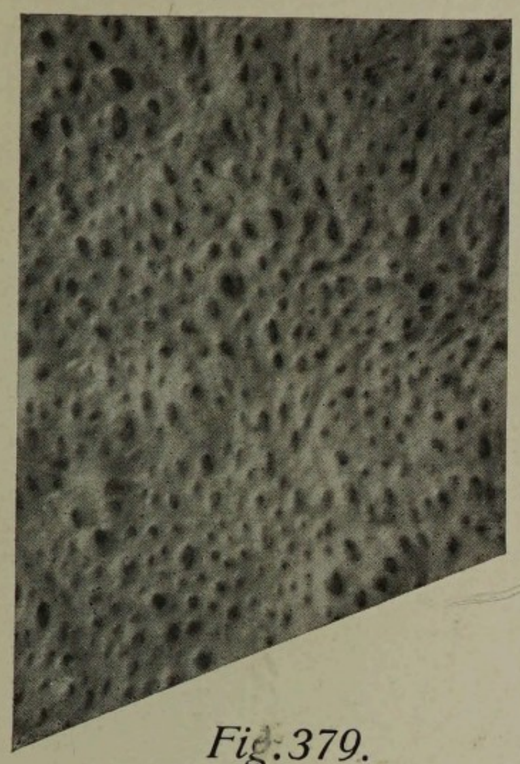


Fig. 379.

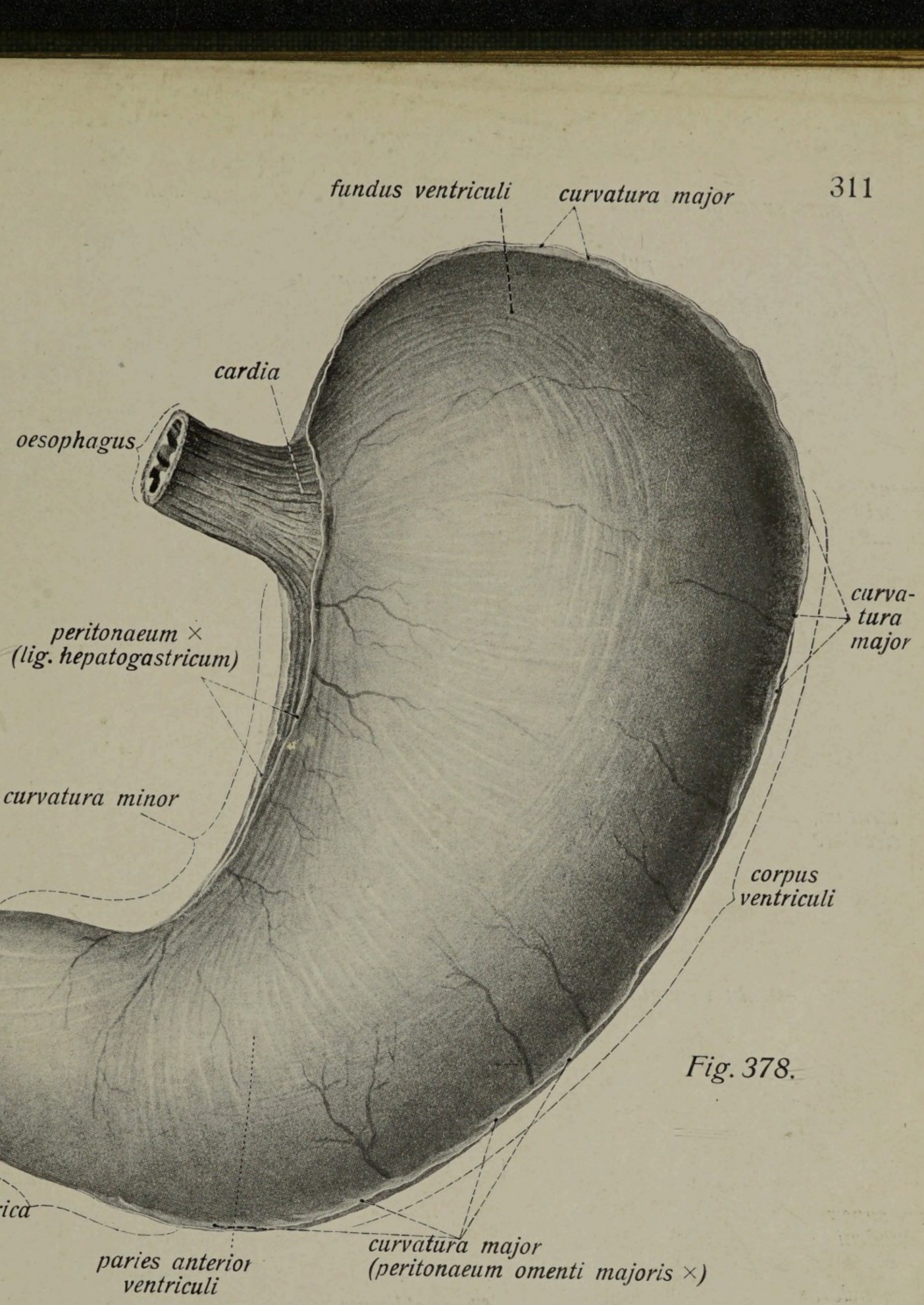


Fig. 378.

Fig. 380.

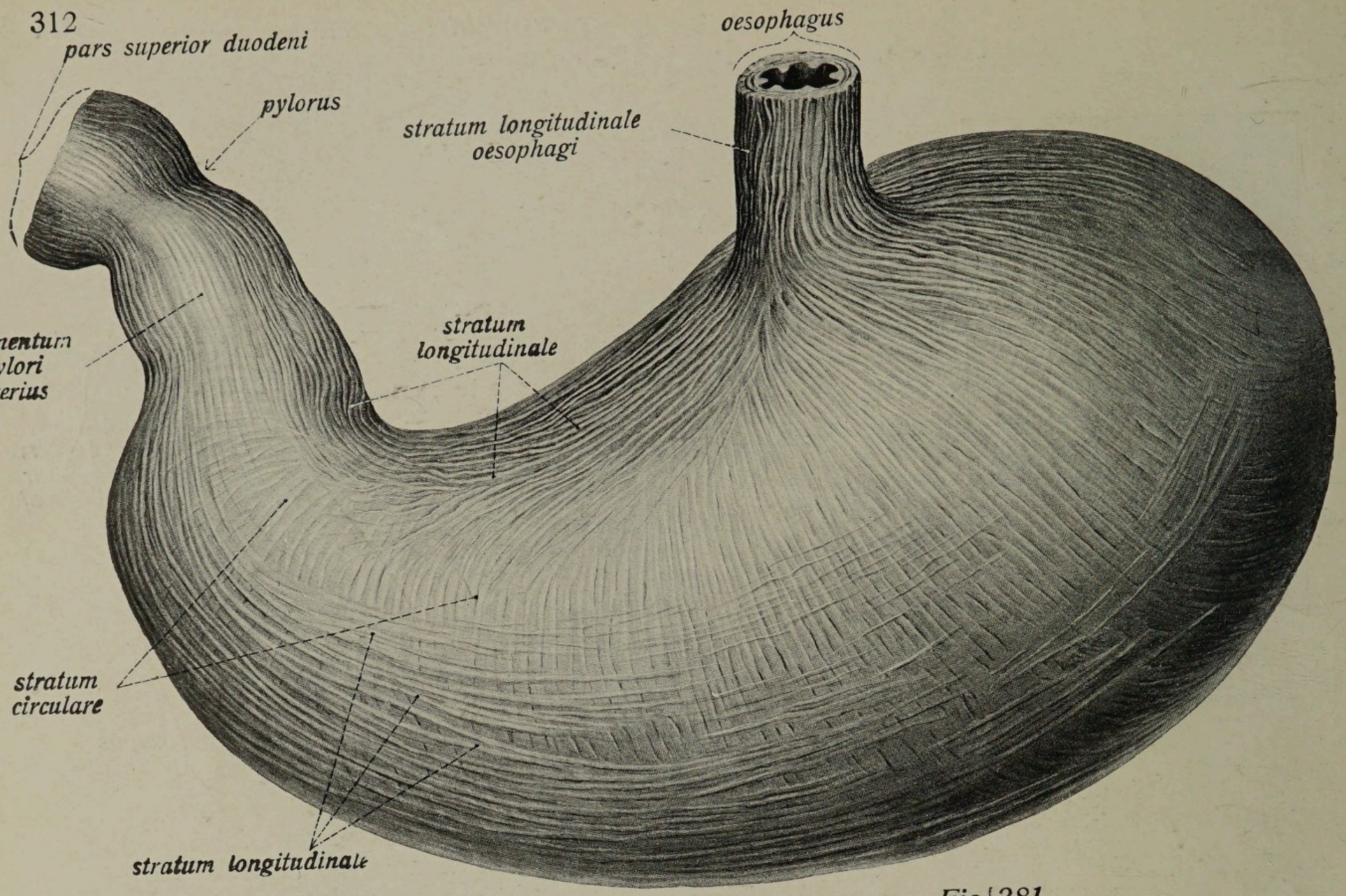


Fig. 381.

Fig. 382.

The Digestive Organs. The Stomach. (Cont.)

Fig. 381. The superficial musculature of the stomach after removal of the peritoneum, from in front and somewhat from above. ($^3/_4$)

Fig. 382. The deeper layers of the musculature of the stomach, from in front. ($^3/_4$) The longitudinal musculature is entirely removed, the circular in the upper portion. The musculature of the duodenum is not prepared.

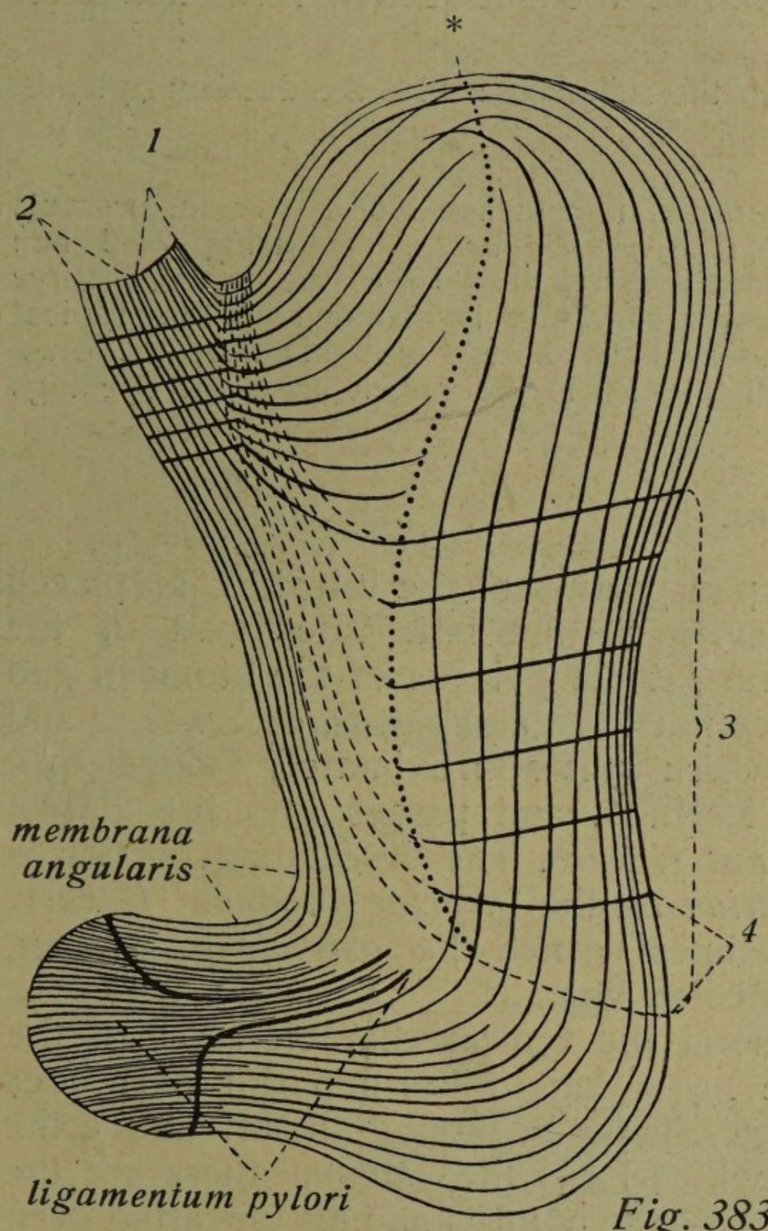


Fig. 383.

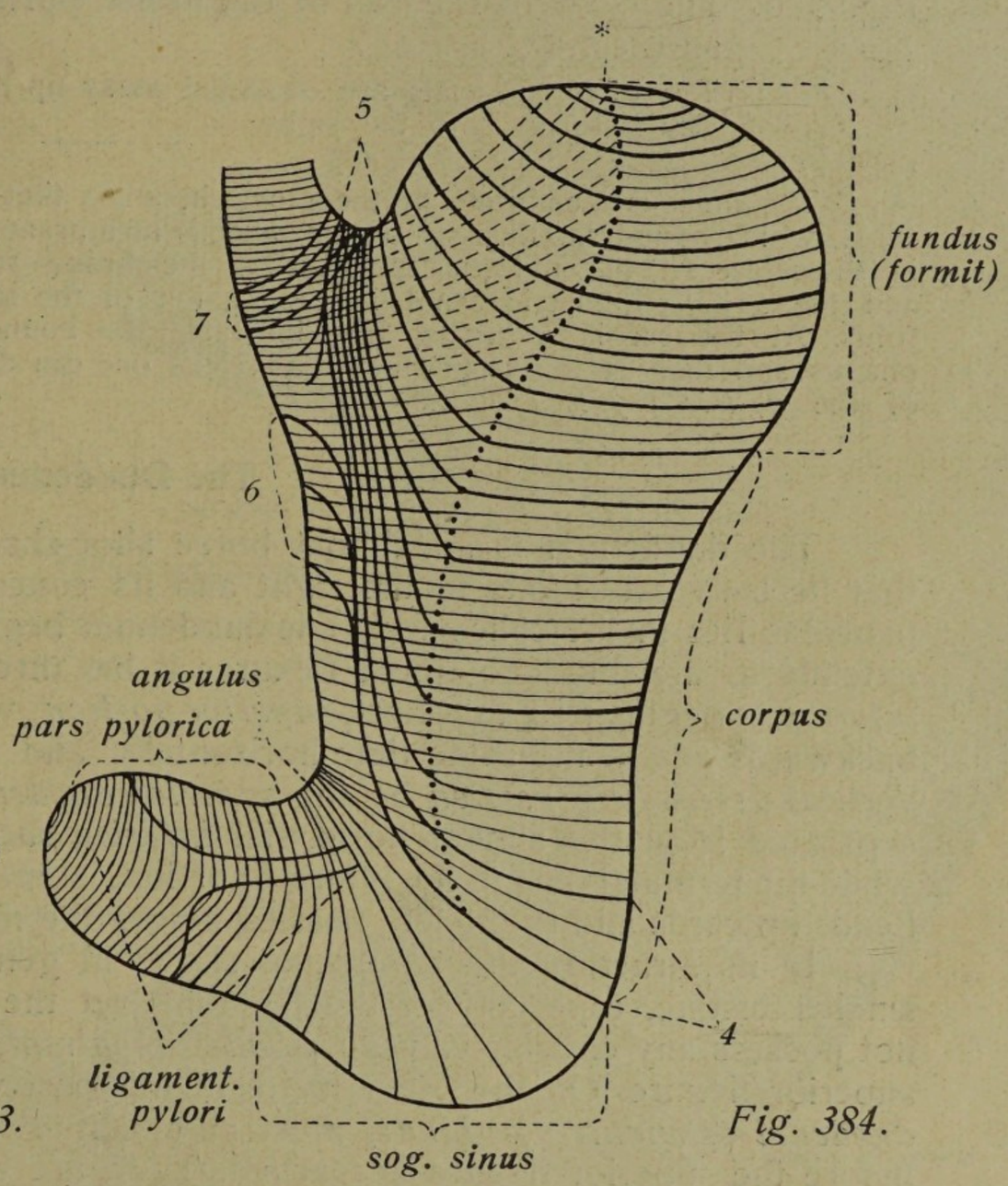


Fig. 384.

Fig. 383. Diagram of the longitudinal musculature of the stomach (after Forsell).
Fig. 384. Diagram of the circular and oblique musculature of the stomach (after Forsell).

* = line of insertion of the oblique musculature.
1 = medial longitudinal bundle.
2 = cardiac radiation on the fundus.
3 = circular portion of the inner layer on the body.
4 = lower segmental loops.
5 = supporting loops.
6 = fibres connecting the supporting loops.
7 = cardiac fibres of the inner layer.

The musculature of the stomach consists exclusively of non-striated fibres and is arranged in general in three layers, which, however, are not all present in all parts of the stomach. The middle circular layer, which is also the strongest, extends over the entire stomach; at the pylorus it forms the *pyloric sphincter*. The outer longitudinal layer is developed chiefly along the curvatures and especially on the lesser curvature, but bundles spread out obliquely over the body and fundus, where they are gradually lost. It is directly continuous with the longitudinal musculature of the oesophagus. Only in the pyloric portion does it form an almost continuous layer, especially thick on the anterior and posterior surface, forming there the so-called *pyloric ligaments*. The innermost layer is termed the *oblique layer*. It is well developed only over the fundus and body and its fibres run obliquely from the left side of the cardia, at first almost parallel with the lesser curvature and then in an oblique direction, partly crossing with the fibres of the circular layer.

The Digestive Organs. The Stomach and Duodenum. (Cont.)

Fig. 385. The Stomach and principal portion of the duodenum opened, from in front. ($^3/_4$)
Sounds are inserted into the openings of the bile duct and both pancreatic ducts.

Fig. 386. The coats of the wall of the upper portion of the duodenum, from the outer surface. ($^1/_1$)
The different coats are dissected away up to the submucosa with the duodenal glands. The pylorus is to the right.

The mucous membrane of the stomach, when that organ is contracted or partly so, presents folds, which bound small areas of the mucous membrane, the *gastric areas*, measuring 2—3 mm in diameter. At the pylorus the mucous membrane forms a circular fold, the *pyloric valve* and the so-called gastric canal in the region of the lesser curvature is bounded by longitudinal folds. At the cardia a zigzag line indicates the boundary between the epithelium of the oesophagus and that of the stomach. With a lens one can distinguish in the gastric areas the openings of the *gastric crypts (foveolae)*.

The Duodenum.

The **duodenum** is an almost horse shoe-shaped portion of the intestine, so placed that its convexity looks to the right and its concavity to the left. The head of the pancreas lies in the concavity. The duodenum begins at the pylorus of the stomach and extends to the duodenojejunal flexure; it has three portions, a *superior*, *descending* and *inferior*. It begins with the short, *superior portion*, which runs approximately from before backwards and at the same time horizontally and laterally, and passes into the almost vertical *descending portion* by the *superior duodenal flexure*. The descending portion is separated from the almost horizontal *inferior portion* by the *inferior duodenal flexure*, while the terminal part of the inferior portion, sometimes termed the *ascending portion*, bends upwards and to the left, passing across the median line.

In its structure the duodenum shows in general the typical characteristics of the small intestine, especially of the jejunum, yet the beginning of the superior part does not possess any circular valves *(valvulae conniventes)*, these beginning shortly above the superior flexure. On the other hand, in this part which lacks the valvulae there are the *duodenal (Brunner's) glands*, most abundant towards the pylorus and disappearing even before the superior flexure is reached. They are situated in the submucosa and are individually about the size of grains of millet.

In the descending portion are the orifices of the pancreatic ducts and the bile duct. The latter, the ductus choledochus, traverses the wall of the duodenum obliquely and forms a vertical fold of the mucous membrane, the *longitudinal fold*. At the lower end of this is the common opening of the bile duct and the greater pancreatic duct, which usually before reaching the opening forms a small enlargement of the fold, the *duodenal diverticulum* (greater duodenal papilla). The longitudinal fold crosses the circular valves at right angles; it is very low, but is the only longitudinal fold of the entire duodenum. It lies on the posterior medial wall of the duodenum. Somewhat higher, i. e. nearer the pylorus, on a small, wart-like elevation, the (lesser) *papilla*, is the opening of the lesser or accessory pancreatic duct; this and the papilla may be quite small or even occasionally wanting. The inferior portion of the duodenum differs only in its position from the jejunum, into the upper part of which its ascending portion passes over, without any demarcation, by the *duodeno-jejunal* flexure. At this flexure the duodenum is attached to the posterior body wall by a muscle bundle (the suspensory muscle of the duodenum, muscle of Treitz).

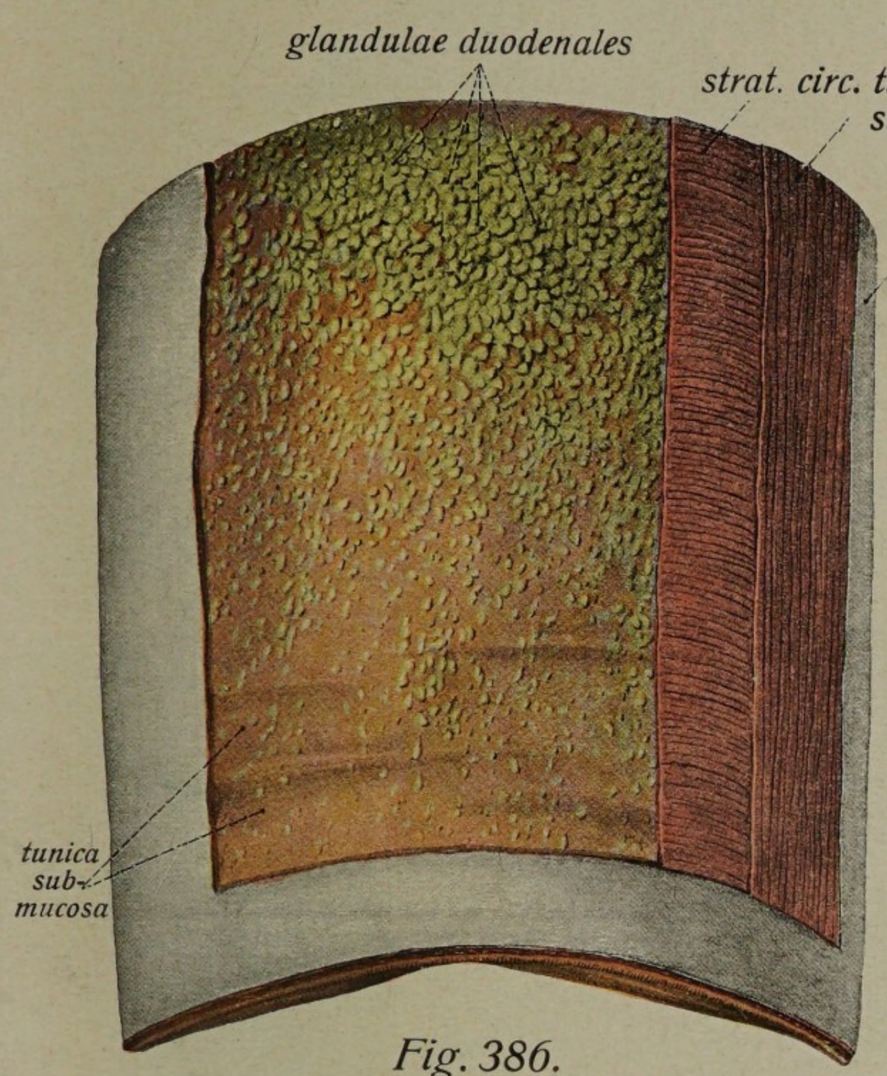


Fig. 386.

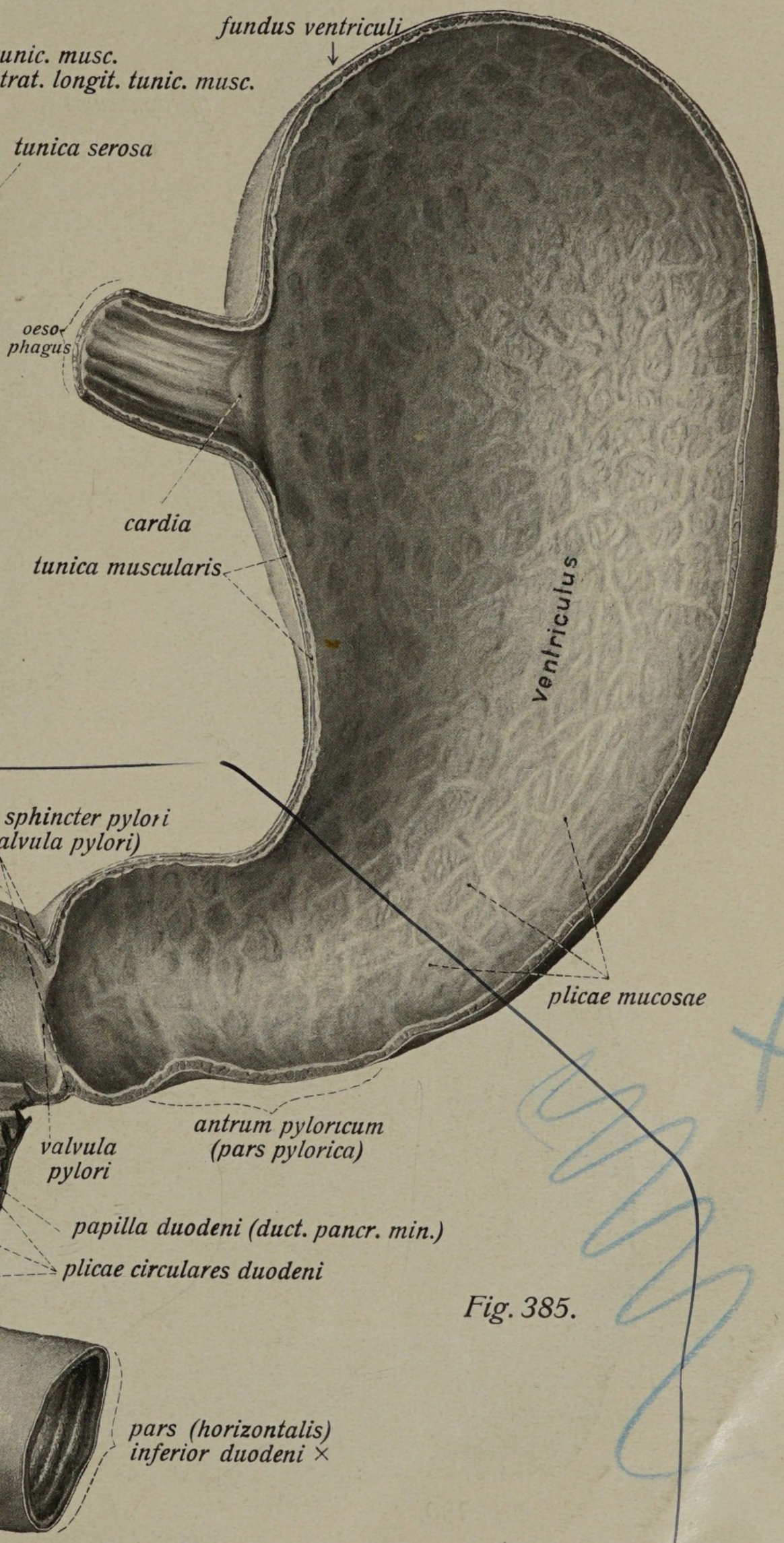
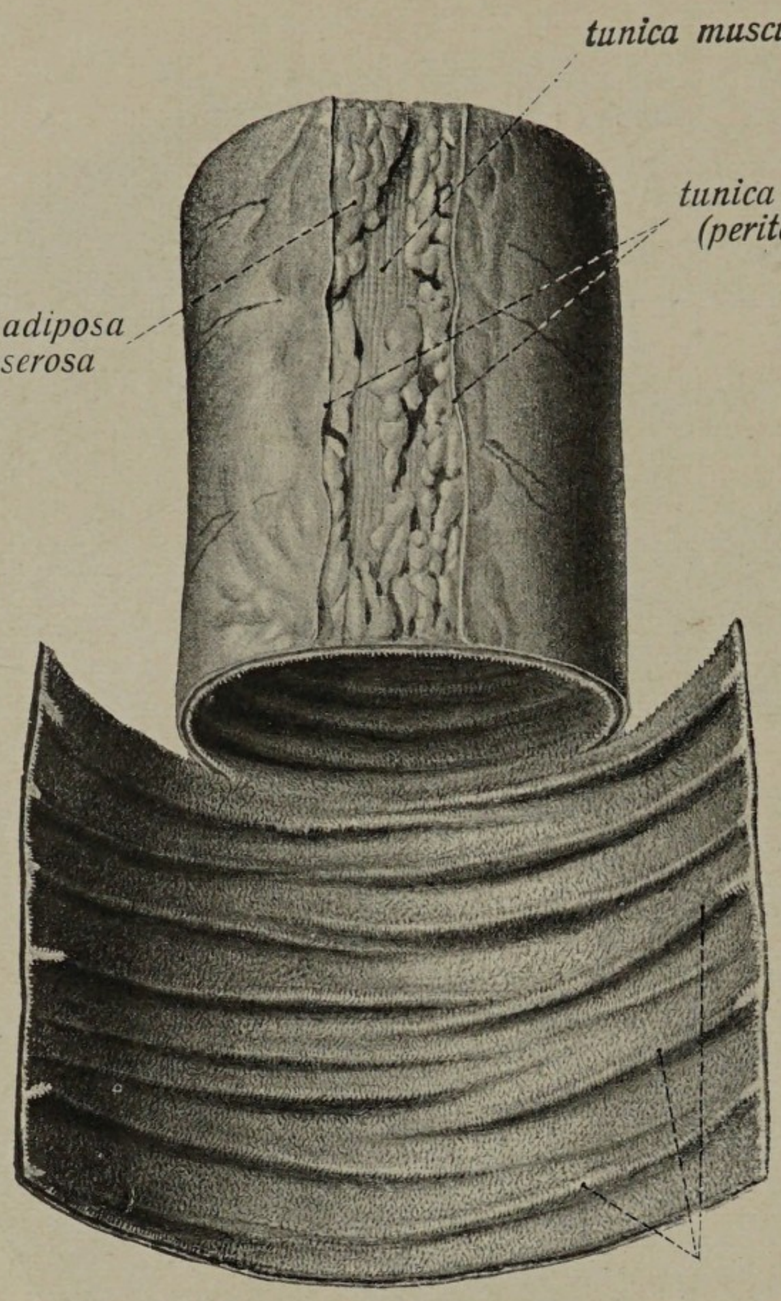


Fig. 385.



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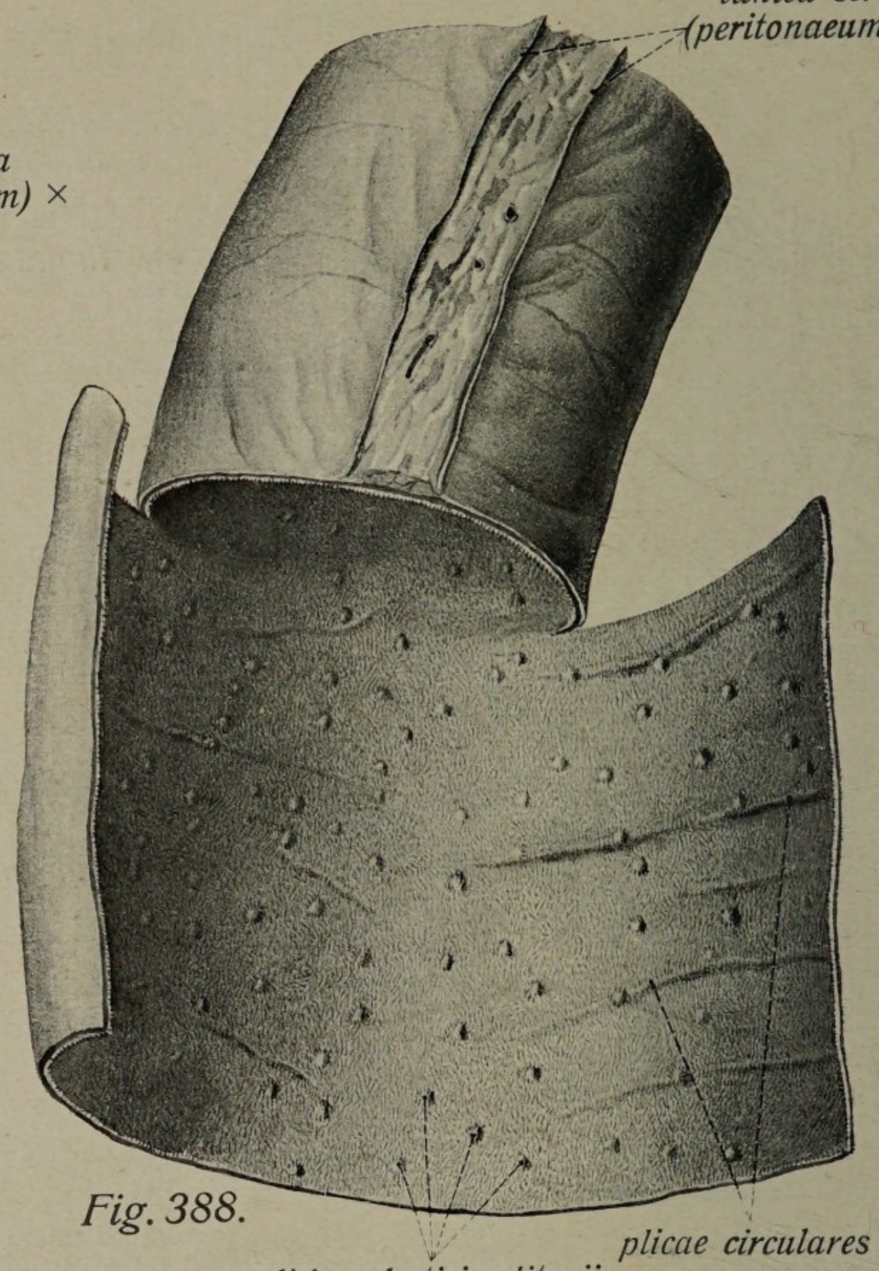


Fig. 388.

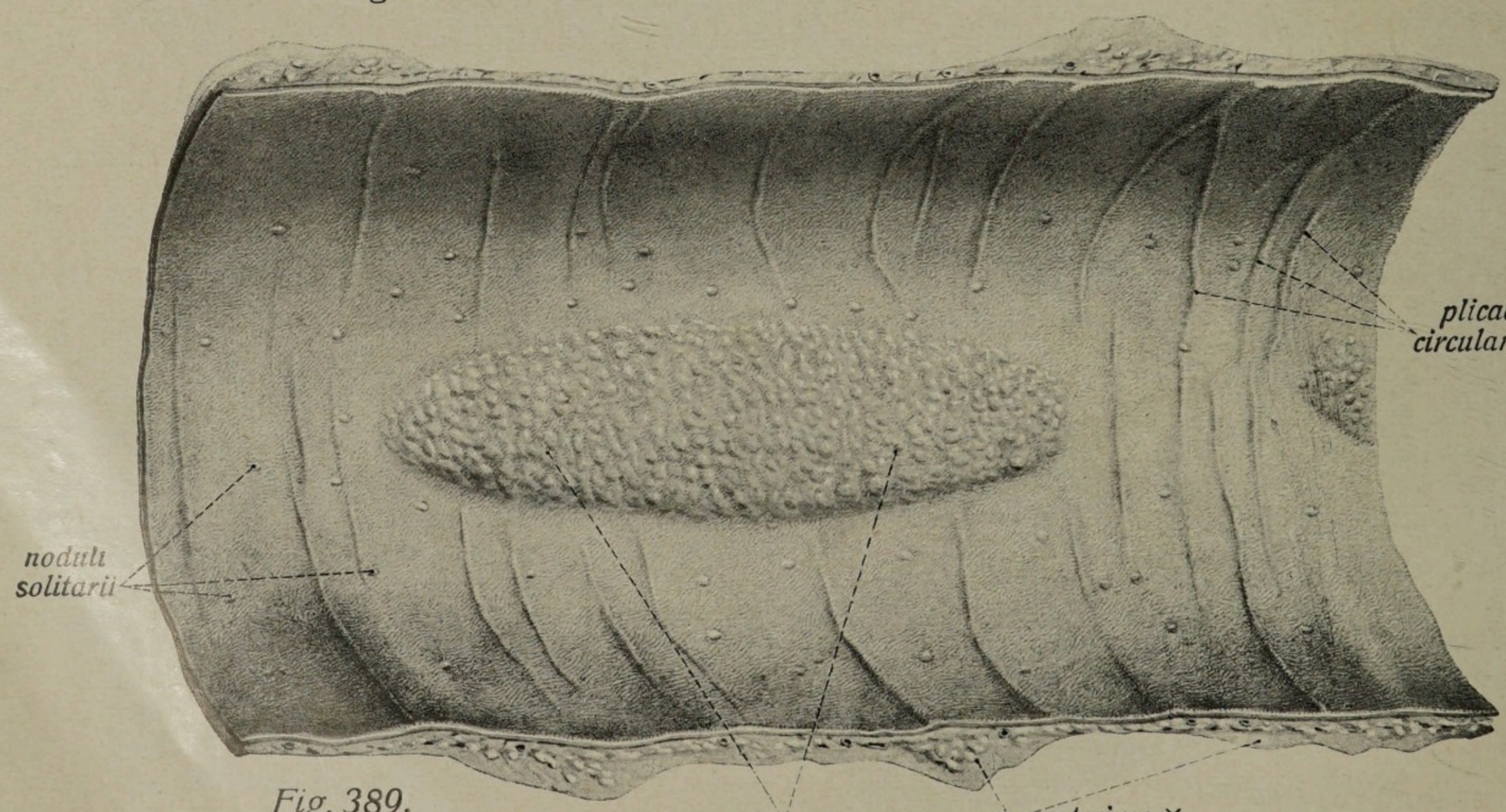


Fig. 389.

Fig. 387. A portion of the jejunum, half of which is cut open along the line of attachment of the mesentery. ($^1/_1$)

Fig. 388. A portion of the ileum prepared as in Fig. 387. ($^1/_1$)

Fig. 389. A portion of the lower ileum opened along its entire length by a cut along the line of insertion of the mesentery. ($^1/_1$)

The Small Intestine, *intestinum tenue.*

The small intestine, *intestinum tenue*, is a cylindrical tube about 6½ m in length, beginning at the pylorus of the stomach and ending by opening into the large intestine, gradually but markedly diminishing in diameter (from almost 4.5 to 2.5 cm) from above downwards. It consists of two principal portions: the *duodenum* (see p. 313) and a freely moveable portion, the *mesenterial intestine*, so-called because it possesses a freely moveable mesentery, in contrast to the duodenum which is firmly fastened to the posterior body wall. In the mesenterial intestine two parts are recognized, the *jejunum* and *ileum*, which, however, pass into one another without demarcation. The wall of the intestine is quite thin. With the exception of the greater part of the duodenum it is surrounded by peritoneum, which forms the *serous coat* and is separated from the muscular coat by a thin *subserous coat*, which is free from fat except along the line of attachment of the mesentery. In addition there is a *muscular coat*, consisting of a continuous outer longitudinal layer and an inner circular one; a *submucous* and a *mucous coat*, the latter, like that of the entire digestive tract, possessing a *lamina muscularis mucosae*.

The mucous membrane of the small intestine, in addition to the tubular glands or crypts of Lieberkühn (*intestinal glands*), possesses *villi* throughout its entire extent, these giving to its interior a characteristic satiny appearance. Further the mucosa forms transverse folds, the *circular folds (valvulae conniventes)*. These begin at about the superior duodenal flexure and extend to the lower end of the small intestine, becoming, however, gradually fewer and lower in the ileum, until they are either absent or merely scattered in its lower portion. The folds are to be seen only on the inner surface of the intestine and are for the most part, especially in the ileum, crescentic; only rarely do they completely surround the intestine. The mucous membrane of the small intestine is very rich in lymphatic tissue, especially in the ileum, and not only do individual lymph follicles *(solitary nodules)* occur, but also more or less extensive aggregations of these *(aggregated nodules* or Peyer's patches), these latter being found only in the ileum and only on the surface of this opposite the attachment of the mesentery. Frequently they are of considerable size, 10 cm or more in length, and their long axis coincides with that of the intestine.

Fig. 390. The caecum with the lower part of the ileum and the appendix vermiformis, from behind. ($^1/_1$)
Fig. 391. The transverse colon cut across. ($^1/_1$)
Fig. 392. A portion of the transverse colon from in front and below. The right end is opened up. ($^1/_1$) The positions of the taeniae from the inner surface are indicated by their names in parentheses.

The large intestine *(intestinum crasum)*

The large intestine *(intestinum crassum)* is an almost cylindrical tube, of very variable width and 120—150 cm in length. It is divisible into two portions, the *caecum* with the *appendix vermiformis* and the *colon,* and forms a large horse-shoe-shaped loop, open below, surrounding the small intestine. Its general characters are as follows: it is the widest portion of the intestine; its caliber being greatest at the caecum and diminishing toward the rectum from 6—8 to 4—5 cm. Its wall, seen from without, in contrast with that of the small intestine, is not smooth, but presents outpouchings *(haustra)* produced by constrictions. These are due to the arrangement of three bands of longitudinal muscle fibres, the *taeniae,* which extend throughout the entire length of the large intestine. They begin on the caecum at the root of the vermiform appendix and extend over the wall of the intestine as smooth, shining bands, equally spaced and about 8 mm in breadth. One corresponds in position to the attachment of the mesentery and is termed the *mesocolic taenia;* that opposite is the *free taenia* and between these two is the *omental taenia,* so-called because it corresponds to the line of attachment of the great omentum to the transverse colon. The free taenia in the transverse colon is rather below than in front, as it is in the rest of the large intestine, and the omental taenia in the ascending and descending colons is on the lateral surface. If the taeniae are cut away or completely relaxed the haustra disappear. The outer surface of the large intestine is also characterized by the presence of subserous accumulations of fat, which form stalked, irregular, lobe-like appendages, the *epiploic appendages.* They are most abundant on the sigmoid colon and often are aranged in two rows, especially on the descending colon.

In the interior of the large intestine *semilunar* or *sigmoid folds* correspond to the constrictions between the haustra; as a rule each is as long as the interval between two taeniae, but they may be longer. In general the mucous membrane of the large intestine is smooth, since it possesses no villi such as occur in the small intestine.

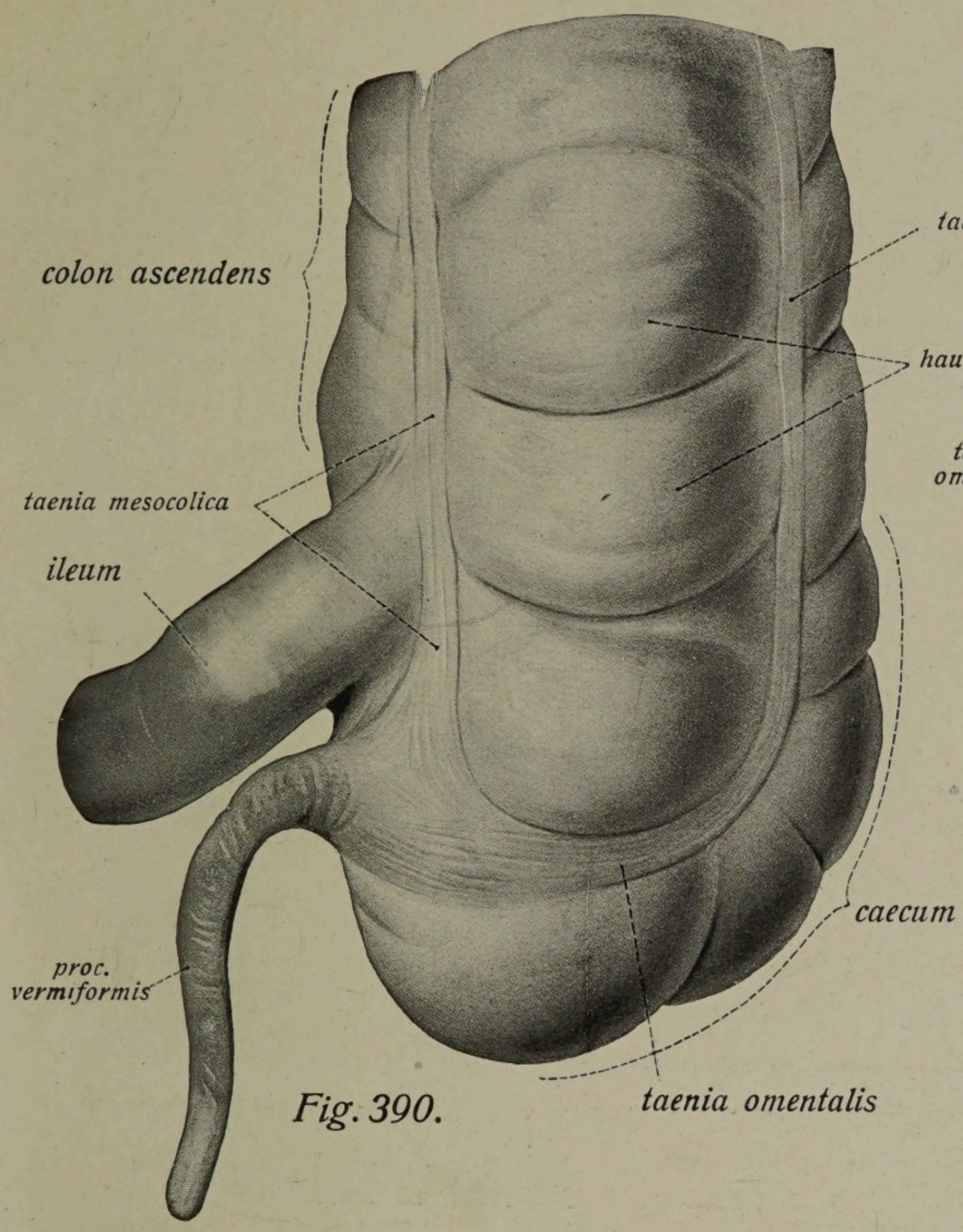


Fig. 390.

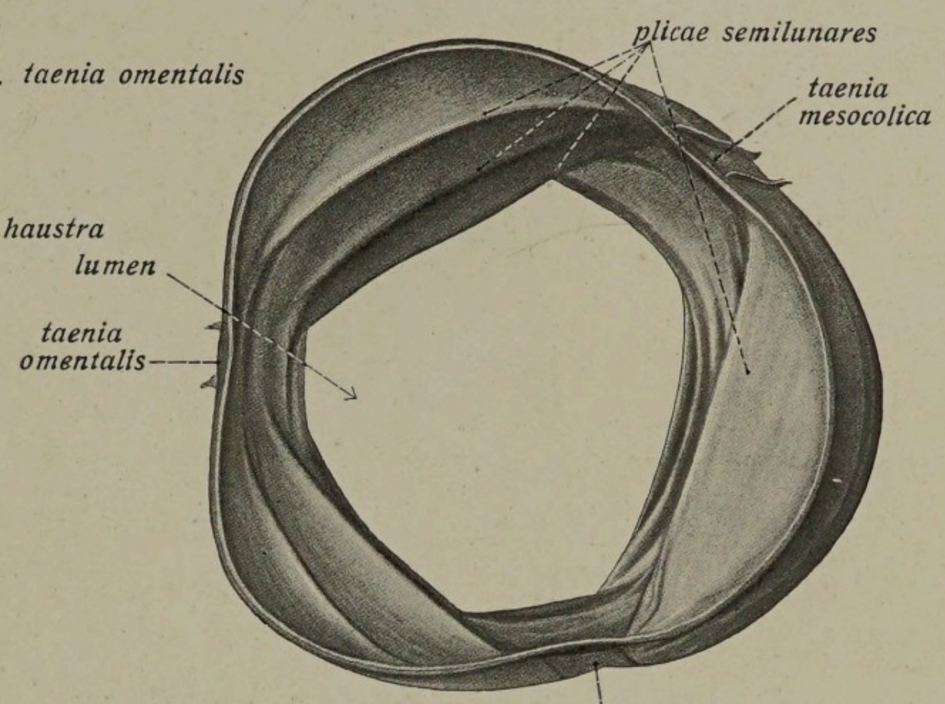


Fig. 391.

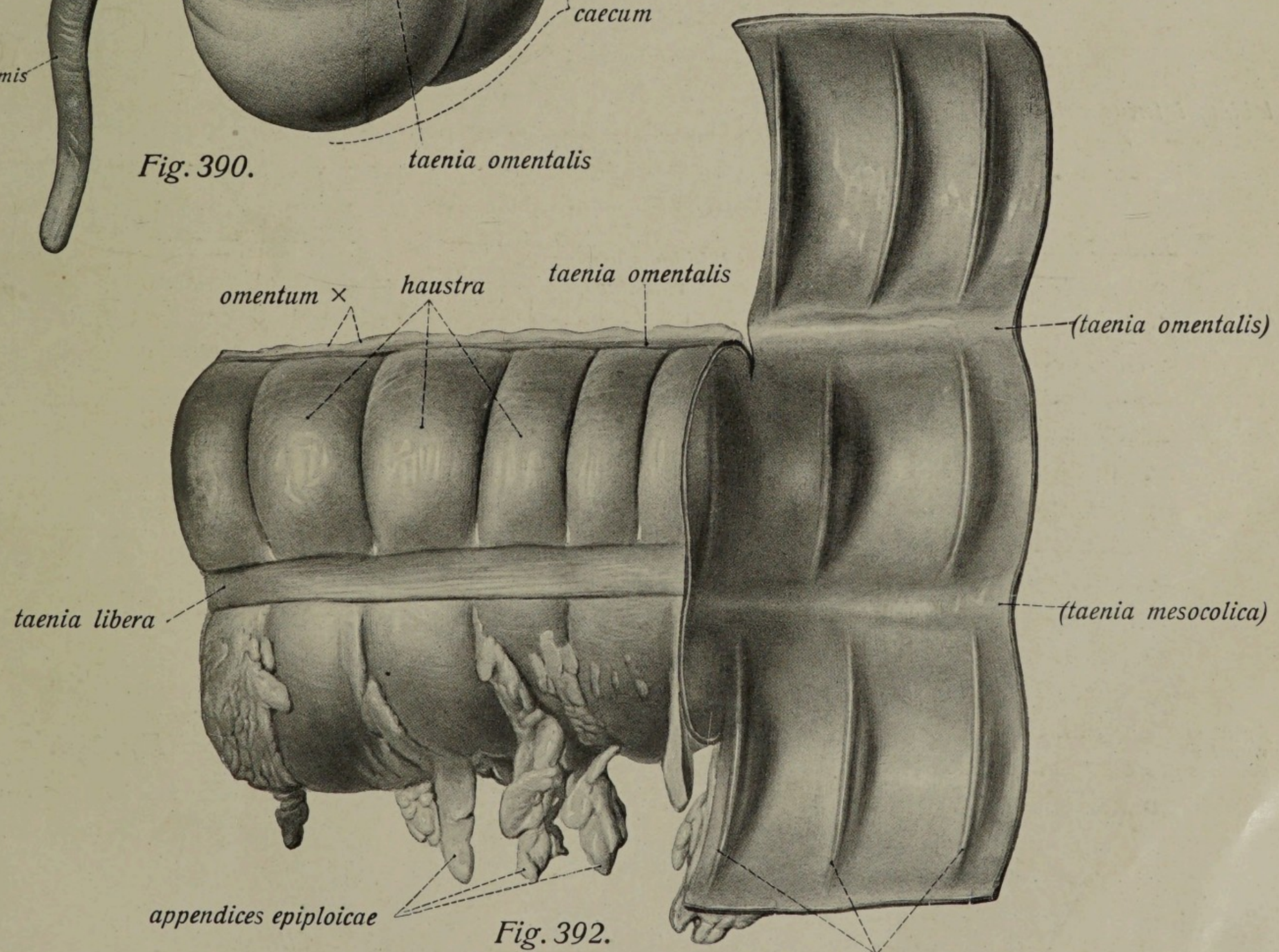
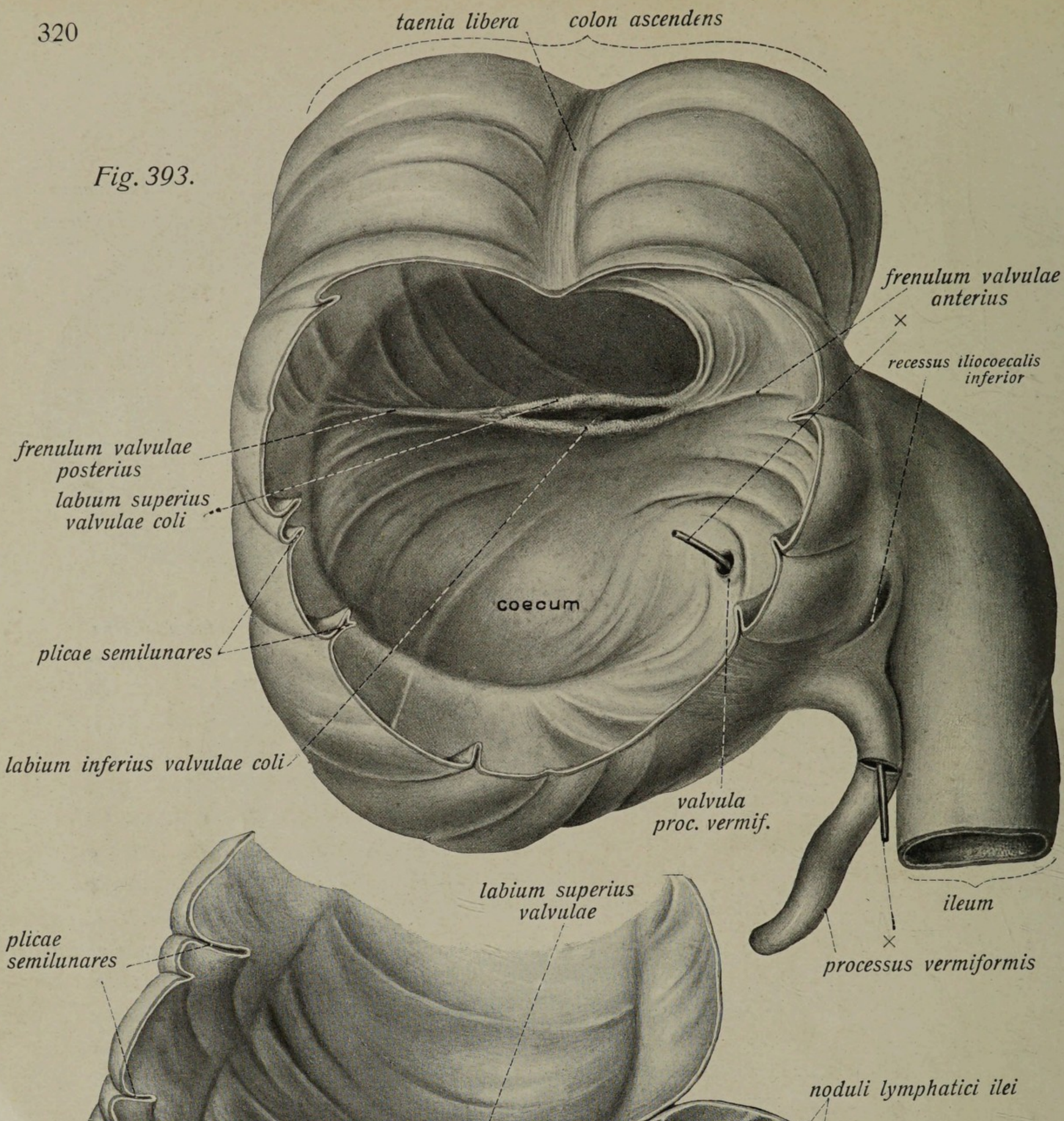


Fig. 392.

Fig. 393.



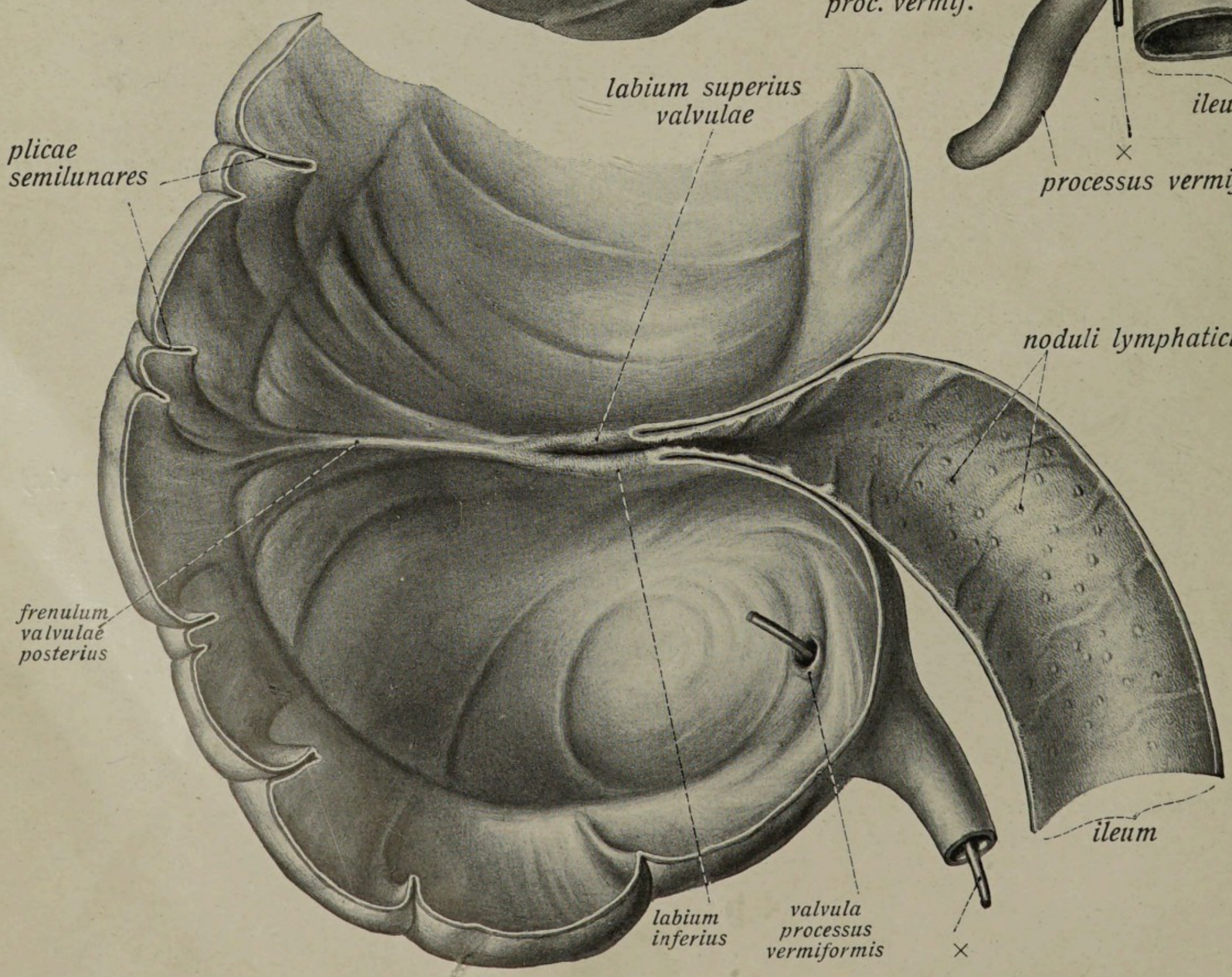


Fig. 394.

The Digestive Organs. The Caecum.

Fig. 393. The caecum with the lower part of the ileum and the vermiform appendix, in the distended condition and opened from the side. ($^1/_1$)
The vermiform appendix is cut across at about the middle of its length and a sound (x) passed into the caecum.

Fig. 394. The caecum and lower part of the ileum cut by a frontal section. ($^1/_1$)
The vermiform appendix is cut across near its root and a sound (x) inserted.

The caecum is that portion of the large intestine that is below the opening of the ileum. It is about 7 cm in length, is somewhat spherical and is the widest portion of the intestine. On its medial wall there is a valve at the entrance of the ileum, the *valve of the colon* (ileocolic valve), formed by two folds of mucous membrane, the *upper* and *lower lip*. These lips project into the caecum.

From the lips semilunar folds pass to the anterior as well as the posterior wall; they run transversely like the semilunar folds, which they resemble except that they are longer. They are termed the *anterior* and *posterior frenula*.

The *vermiform appendix (processus vermiformis)* is a rudimentary, slender thin, blind appendage of the caecum, very variable in its development. It averages 7—9 cm. in length, but may frequently be shorter or longer. In the child it arises from the tip of the conical caecum, but in the adult from its medial and posterior wall. It is usually curved or slightly coiled. At its opening into the caecum there is a variable, valve-like crescentic fold of the mucous membrane, directed downwards and to the right, the *valvule of the vermiform process*.

The *colon,* the longest portion of the large intestine may be divided into four portions; a short, *ascending colon,* on the right side, arising directly from the caecum; a *transverse colon* running transversely or slightly upwards from right to left; a *descending colon* on the left side and a *sigmoid colon* connecting with the rectum. The last part, which is also on the left side, is, like the small intestine, arranged in several, usually two, loops, being moveable on account of possessing a mesentery. It lies, consequently, often in the neighborhood of the caecum and very often in the true pelvis. Its length varies greatly (20—45 cm). At the junction of the ascending and transverse colons there is a bending of the intestine almost at right angles, the *right* or *hepatic flexure* and at that of the transverse and descending colons there is a more acute *left* or *splenic flexure*. The descending colon is distinctly longer than the ascending.

The Digestive Organs. The Rectum.

The Rectum.

The *rectum* extends from the sigmoid colon to the anus, arising from the sigmoid just below the promontory. Its length is somewhat less than 20 cm. It is in general a cylindrical canal whose outer surface, in contrast to that of the colon, is smooth, so that it resembles the small intestine rather than the large. This is due to the fact that the taeniae of the colon spread out on the rectum, so that there is again a continuous and rather strong layer of longitudinal muscle fibres. The upper, greater portion of the rectum, situated in the true pelvis, the *pelvic portion,* is concave forwards, resting on the anterior surface of the sacrum; the lower, shorter *perineal portion* is convex anteriorly, bending around the tip of the coccyx, and passes through the musculature of the pelvic floor.

The inner surface of the rectum lacks the folds that characterize the colon, yet it does possess a variable number of *transverse folds*. One, rather constant and relatively high, is situated 8—10 cm above the anus, and in its region the circular musculature of the rectum thickens to form the so-called Sphincter ani tertius. Below this fold is a broader portion of the rectum, the *rectal ampulla*. In the lowest part of the rectum, the anal part, there are 6—8 longitudinal folds termed the *rectal columns*. They begin about 2—3 cm above the anus and end rather suddenly in the *anulus haemorrhoidalis,* a ridge immediately above the anal opening. Between adjacent columns there are corresponding depressions, the *rectal sinuses*. Both columns and sinuses gradually fade out above. The openings of the *intestinal glands* of the rectum are readily seen as fine points with a lens.

The actual (smooth) musculature of the rectum is very strong and in addition striated muscles are associated with the anal opening (see p. 426). The longitudinal musculature ends at the upper border of the internal sphincter. The circular musculature at the lower end of the rectum close above the anus thickens over an extent of about 3 cm to form the *internal sphincter ani*, composed of smooth fibres, in contrast to the transversely striated *external sphincter ani*. The wall of the rectum has a peritoneal covering only in its uppermost part and even there only on its anterior and part of its lateral surfaces.

Fig. 395. The rectum from in front. ($^1/_1$)
Fig. 396. The rectum cut open longitudinally. ($^1/_1$)
Fig. 397. The mucous membrane of the rectum. ($^{18}/_1$)

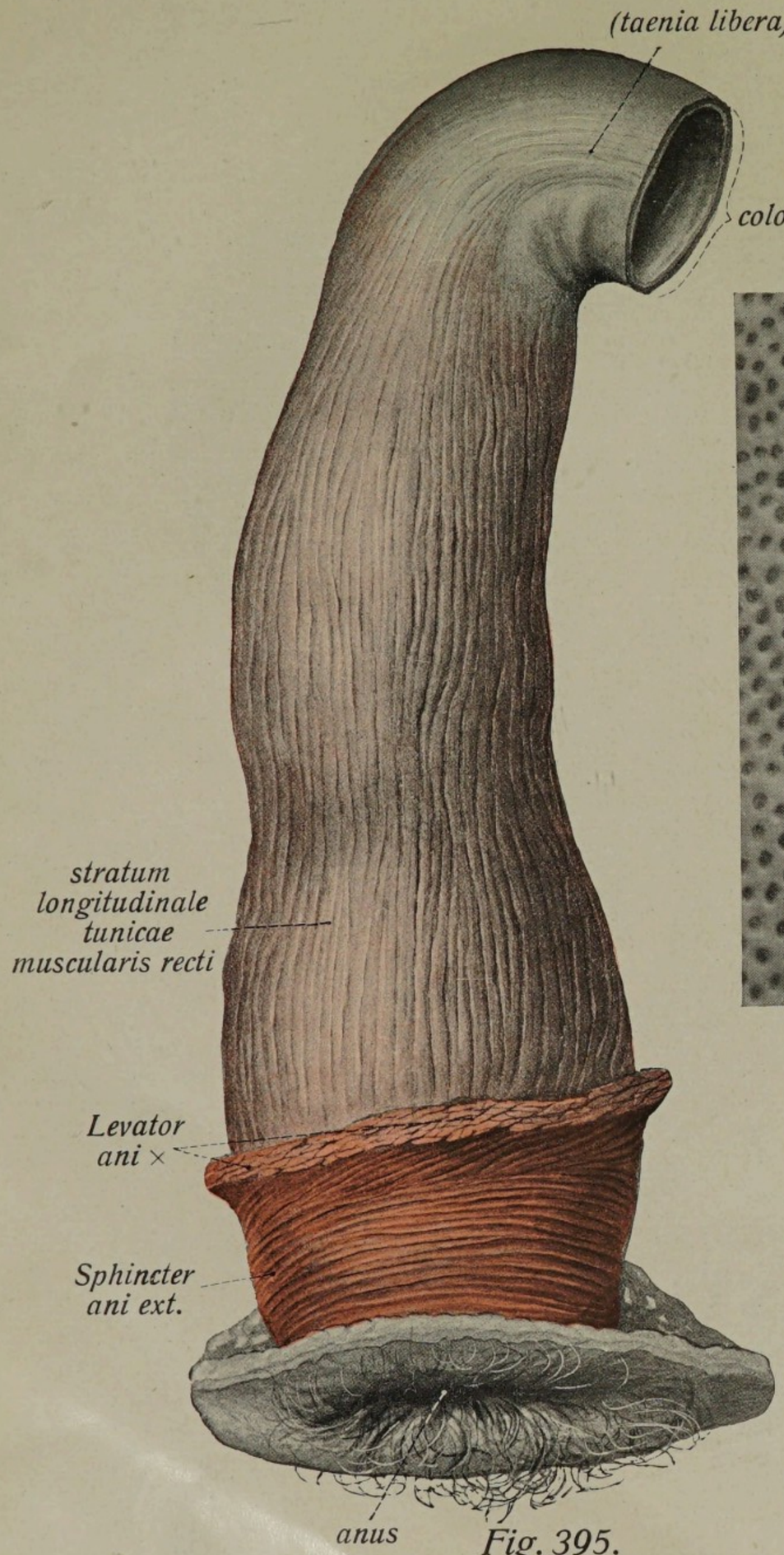
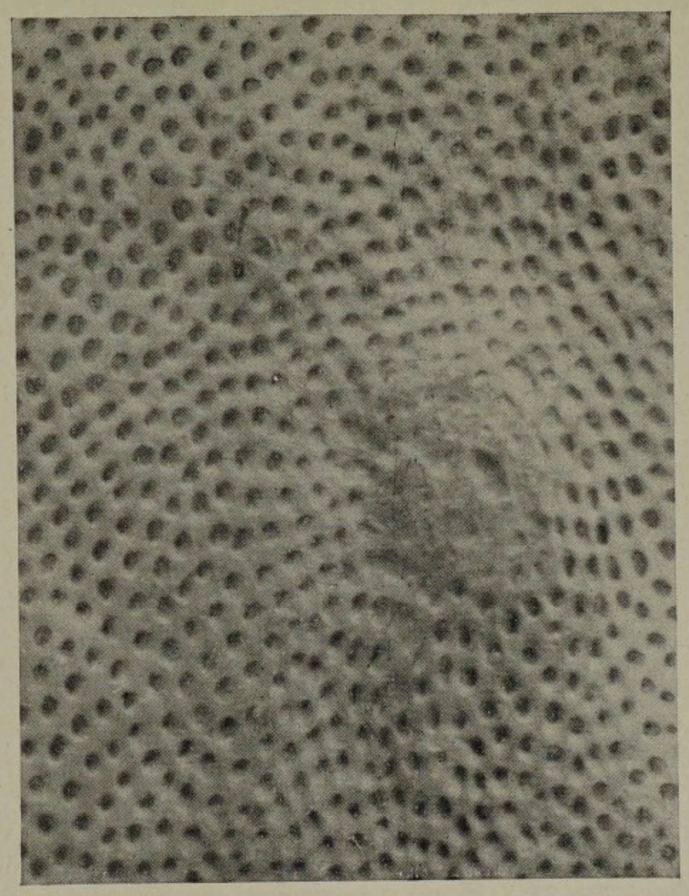


Fig. 395.



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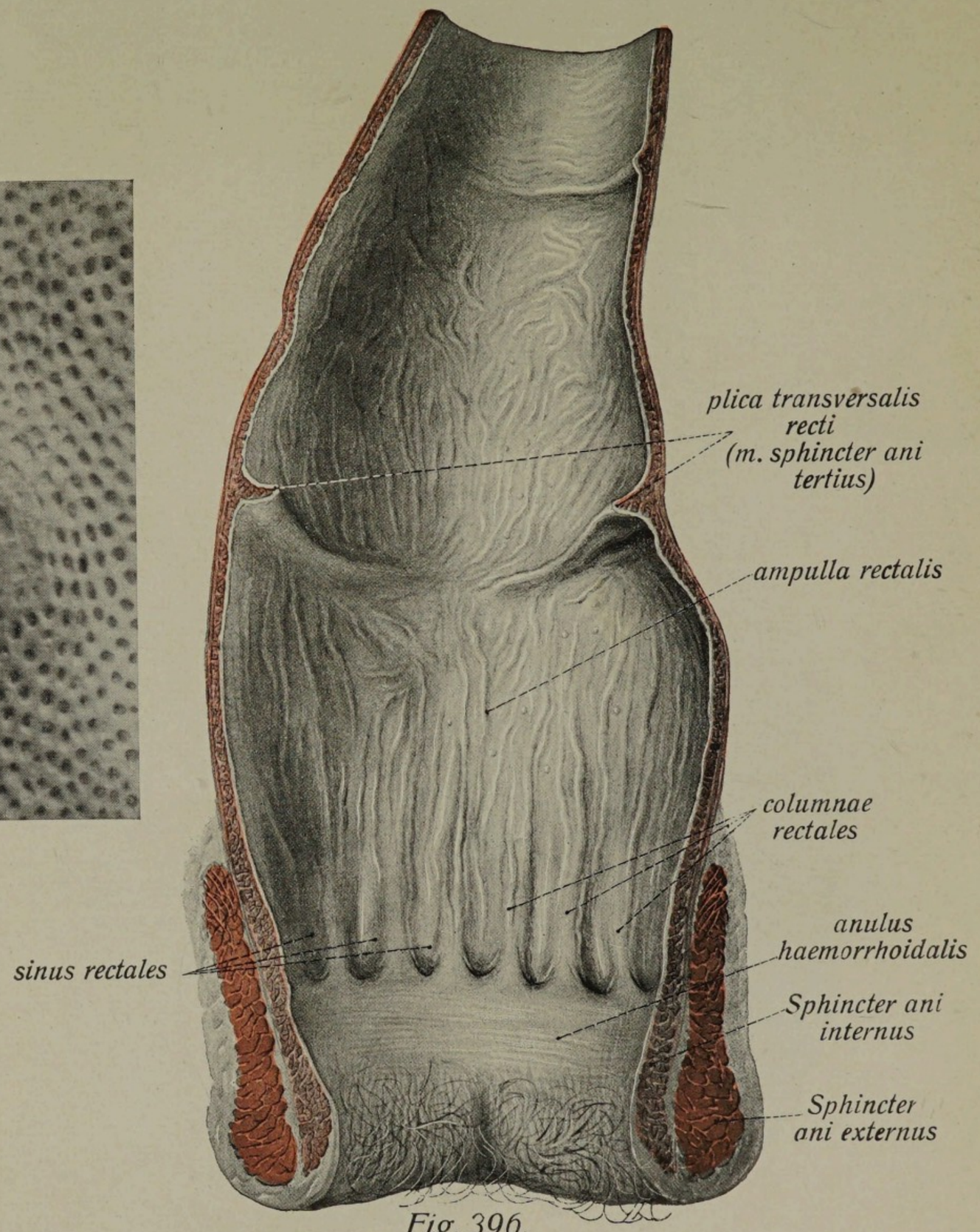


Fig. 396.

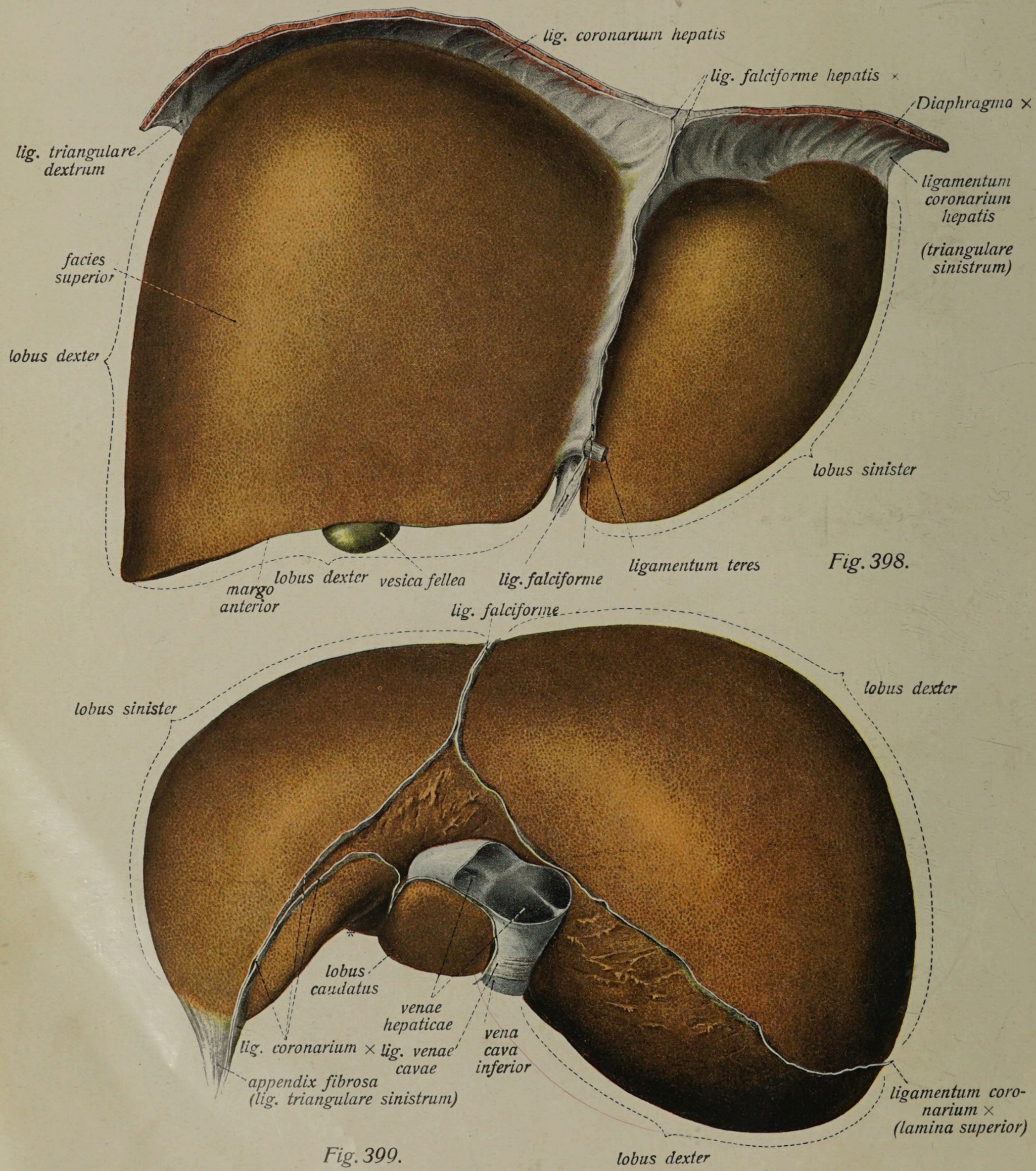


Fig. 398.

Fig. 399.

Fig. 398. The liver with part of the diaphragm from in front. ($^1/_2$)
Fig. 399. The liver from above and behind (posterior surface). ($^1/_2$)
The diaphragm is cut away in the region of the coronary ligament. The area of the liver uncovered by peritoneum is recognizable by the roughness of its surface. * = oesophageal notch.

The Liver, *hepar*.

The liver *(hepar)* is a brown-red organ, of friable consistence and of the form of a halved segment of a sphere; it weighs about 3 pounds. It has two principal lobes, a much larger *right lobe* and a smaller *left lobe*. There is a strongly convex *superior surface,* a *posterior surface,* also convex, and an *inferior surface,* for the most part concave. The superior and inferior surface meet in a sharp *anterior border,* while the small posterior surface passes over into both the large superior and the inferior surface without any definite boundary. On the under surface is the *porta* (portal fissure) which gives entry to the vessels and exit to the bile ducts. It lies almost at the middle of the inferior surface and is a transverse, deep and broad fissure. Into it pass the hepatic artery and the much larger vena portae, each as a rule already divided into its two principal branches, the right and left; further the nerves of the liver accompany the artery. From it emerges, usually by two main branches, the *hepatic duct,* which unites with the *cystic duct* to form the *ductus choledochus* (common bile duct) immediately before (below) the porta, and also a number of lymphatic vessels which pass to the (5—6) *hepatic nodes (lymphoglandulae)* situated in the porta.

In addition to the transverse porta the inferior surface has two parallel sagittal fissures, which unite with the porta to form an H-shaped figure; these are the *right* and *left sagittal fossae*. The right one is broad and shallow and is divided at about its middle by the *caudate process* of the caudate lobe (see below) into an anterior *fossa for the gall bladder* and a posterior *fossa for the vena cava*. Also in the small left sagittal fossa two parts, which pass into one another at the left end of the porta, may be distinguished, an anterior *fossa for the umbilical vein* and a posterior *fossa for the ductus venosus*.

The left lobe of the liver, situated to the left of the left sagittal fossa, makes up only about one-quarter of the entire mass of the organ and shows on its inferior surface a concavity produced by the stomach, the *gastric impression,* and a notch produced by the oesophagus, the *oesophageal incisure*. Only anteriorly and below does the surface show a convexity, the *tuber omentale,* which corresponds to the lesser curvature of the stomach. Its apex ends in the so-called *appendix fibrosa*.

The Digestive Organs. The Liver. (Cont.)

Fig. 401. The liver from below (inferior surface). ($^1/_2$)
Fig. 402. The porta with its vessels and lymphatic nodes (lymphoglandulae). ($^1/_1$)
The inferior vena cava is cut open lengthwise.

The sagittal fossae with the porta bound the areas termed the *quadrate lobe* and the *caudate* (Spigelian) *lobe*, the former lying in front of the porta and the latter behind it. The caudate lobe is well defined by deep grooves on all sides, but it passes over into the right lobe by a small *caudate process*, which separates the two parts of the right sagittal fossa. Opposite this to the right is a rounded *papillary process*, which is covered by the peritoneum of the bursa omentalis and lies in the vestibule of that cavity.

The under surface of the right lobe shows a series of impressions of neighboring organs. The largest of these is the *renal impression* for the right kidney; this is connected by the caudate process with the caudate lobe. Anterior to this is a *duodenal impression* and to the right of it and separated from it by a low ridge is the *colic impression* for the right colic flexure. The *suprarenal impression* is close beside the fossa for the vena cava. The quadrate lobe has a pyloric impression.

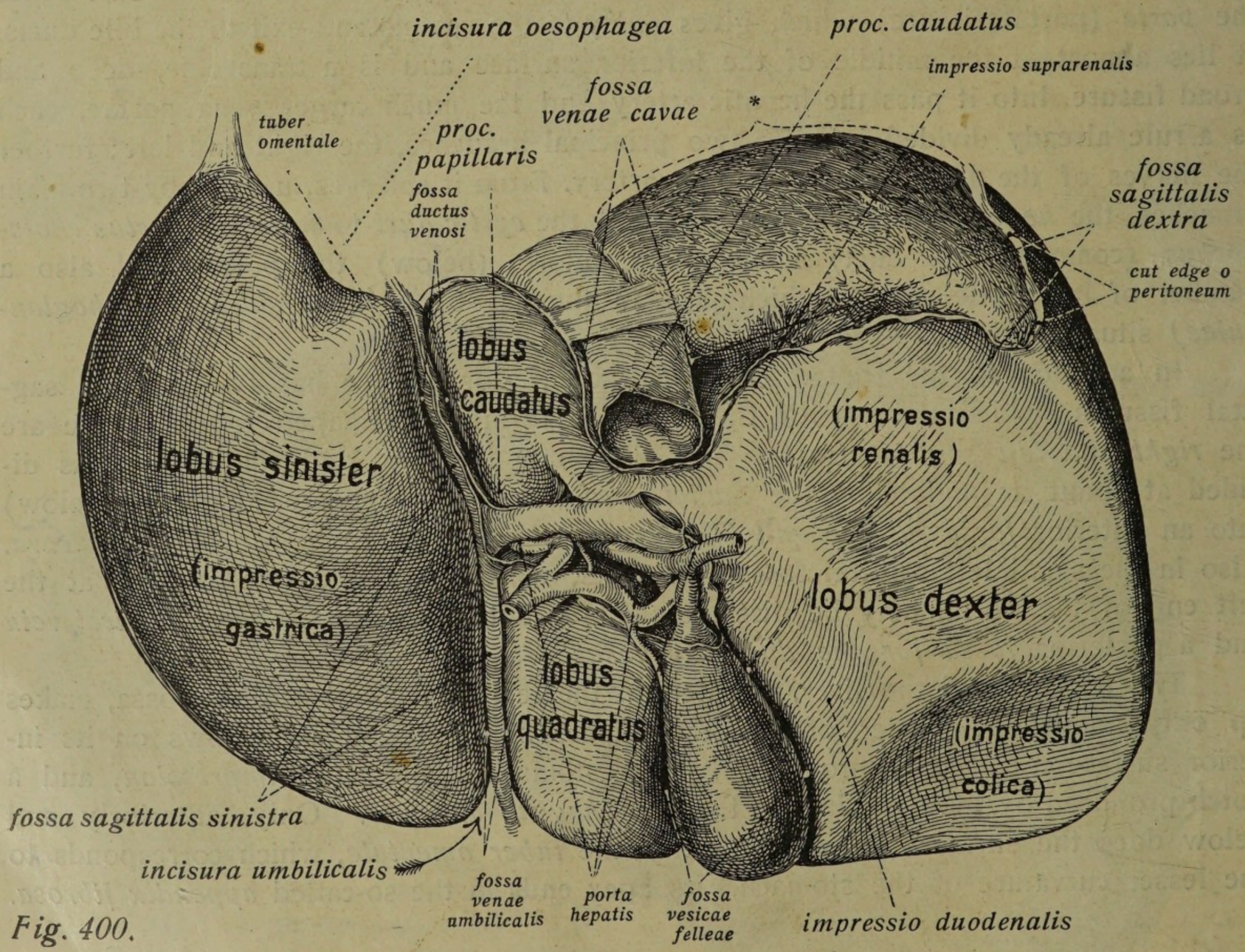


Fig. 400.

Fig. 400. The liver from below. * = surface uncovered by peritoneum.

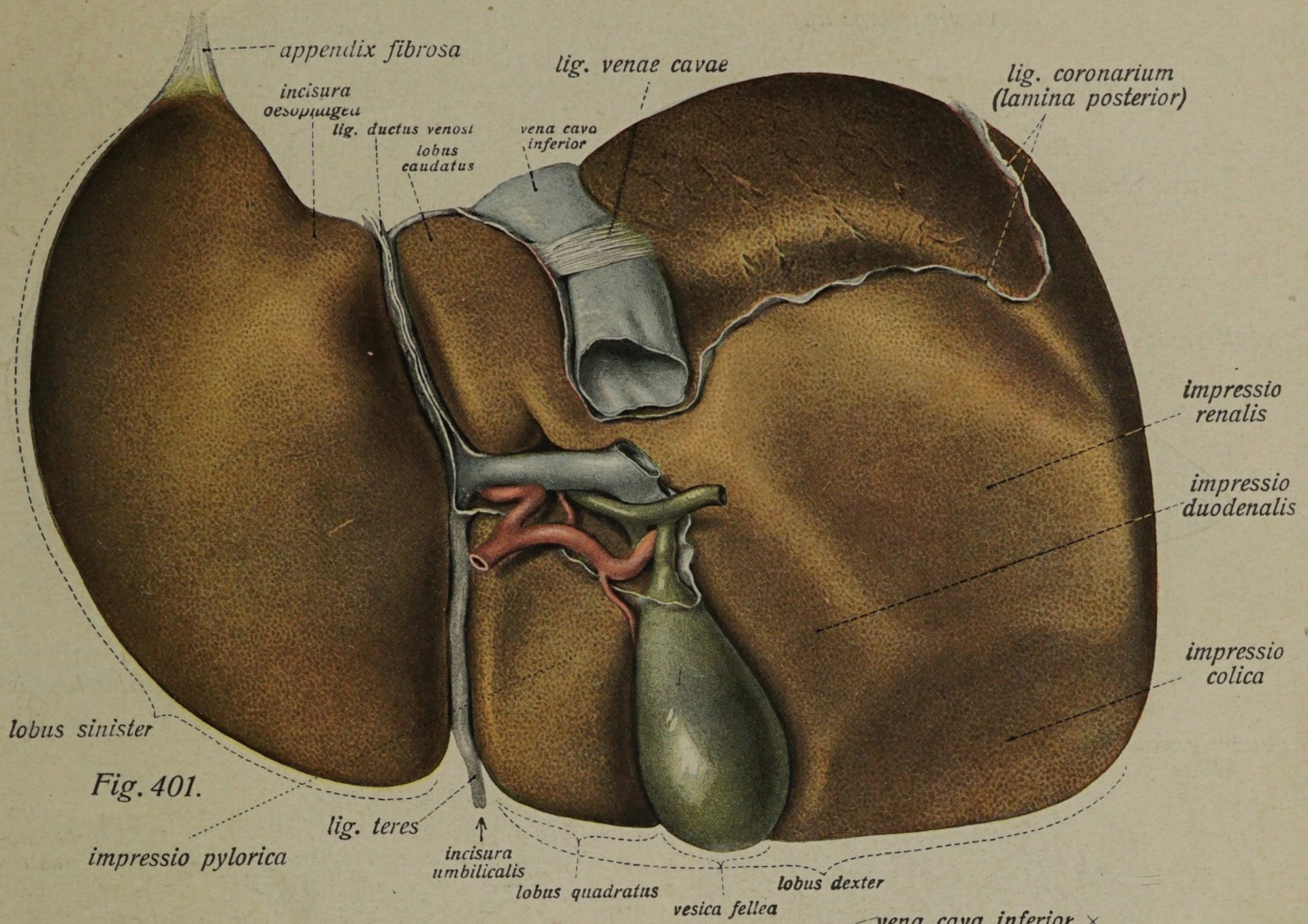


Fig. 401.

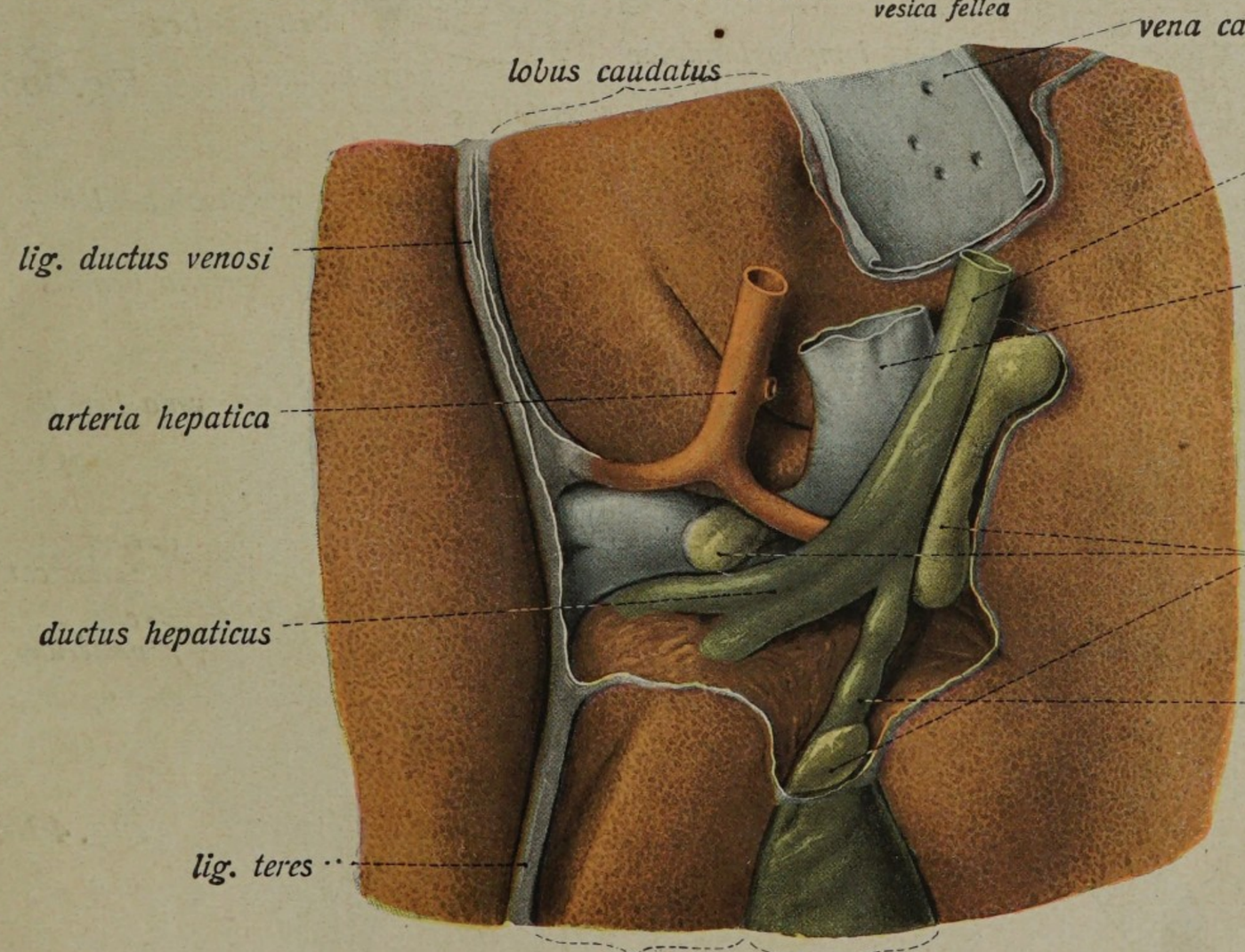


Fig. 402.

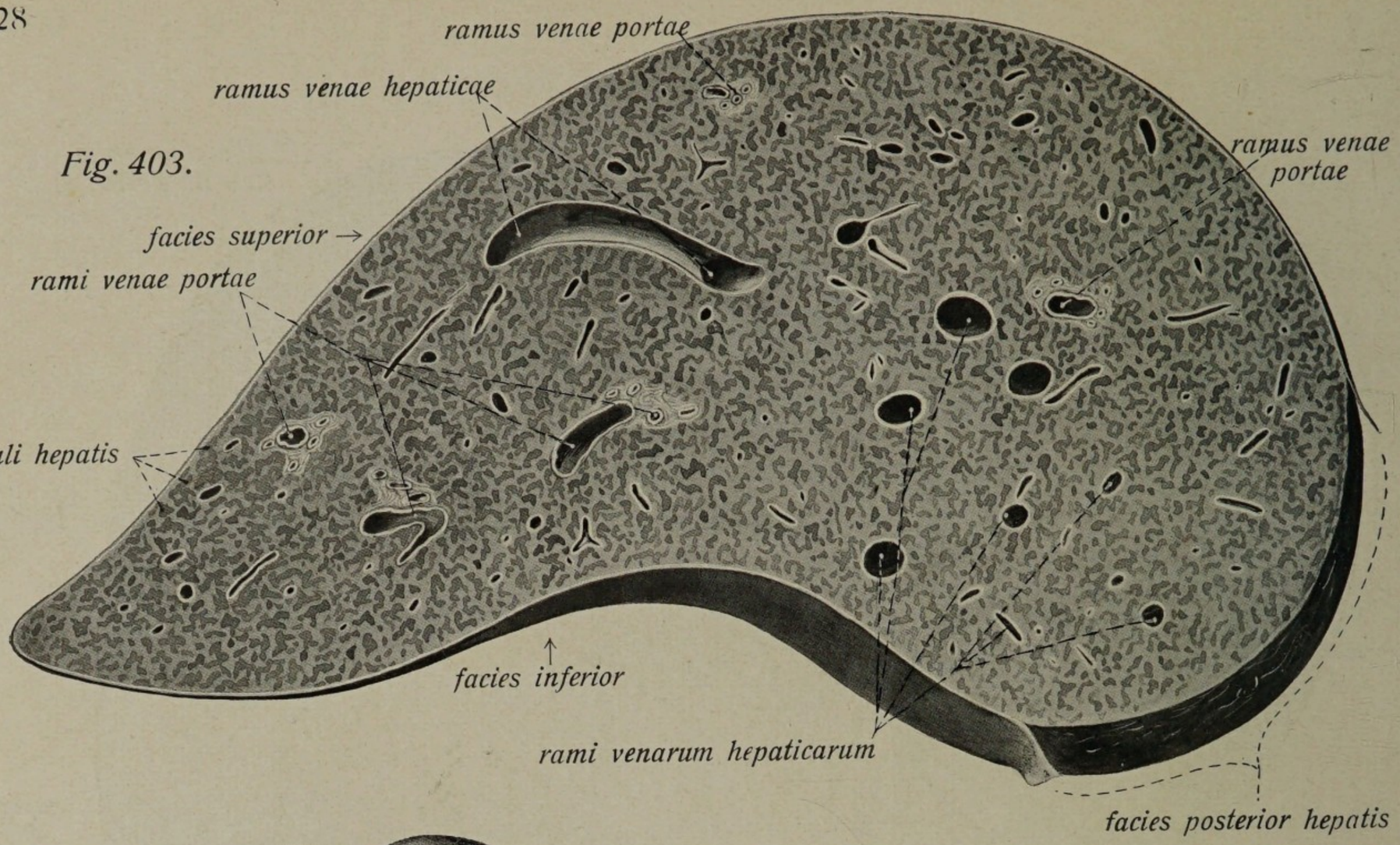


Fig. 403.

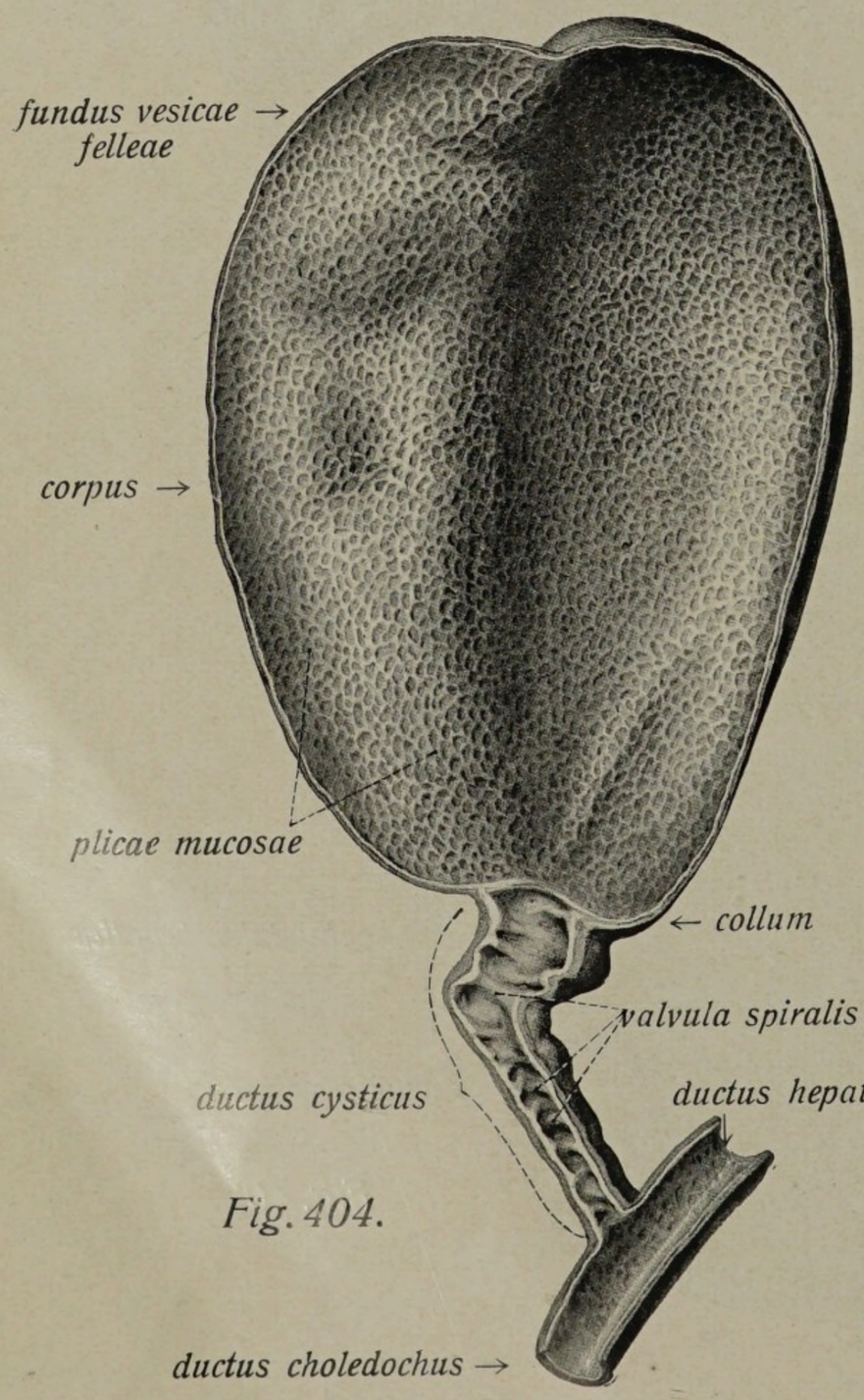


Fig. 404.

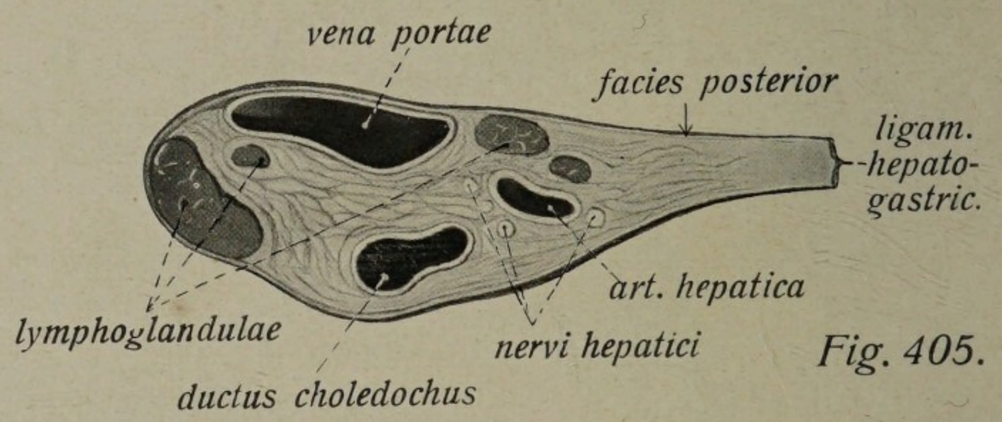


Fig. 405.

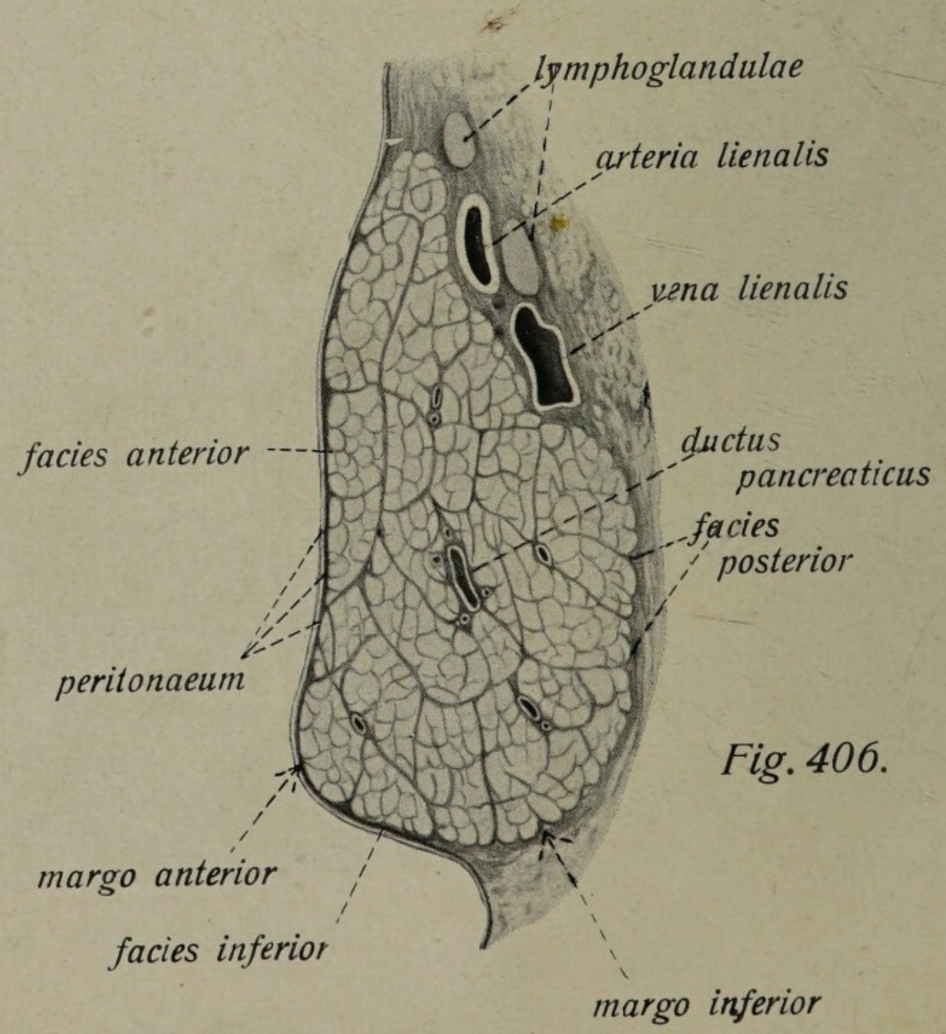


Fig. 406.

The Digestive Organs. The Liver and Gall Bladder.

Fig. 403. A sagittal section of the right lobe of the liver. ($^1/_1$)
Fig. 404. A frontal section of the hepato-duodenal ligament. ($^1/_1$)
Fig. 405. The gall bladder, cystic duct and the adjacent portions of the other bile ducts, opened longitudinally. ($^1/_1$)
Fig. 406. Sagittal section of the pancreas with the splenic (lienal) vessels. ($^2/_3$)

On the *upper surface* of the liver the *falciform ligament*, which encloses the ligamentum teres, indicates the boundary between the right and left lobes. At the anterior border there is an *umbilical incisure*. The *posterior surface*, in the region of the right lobe, has a rather broad area uncovered by peritoneum, which runs out into a small zone on the left lobe. The remaining parts of the liver, except the porta, are completely invested by peritoneum. The extensive, upper surface of the liver, which occupies the concavitiy of the diaphragm, is uniformly convex.

In sections of the liver, in addition to indications of the lobes, which are indistinct in the human liver owing to the absence of definite connective-tissue boundaries, one sees sections of its vessels. The branches of the hepatic veins lie isolated and are closely connected to the liver substance, so that they remain wide open and do not collapse, whereas the branches of the portal vein are surrounded by connective tissue, do collapse and are accompanied by branches of the bile ducts and hepatic arteries. Thus these vascular bundles are readily separable from the liver tissue on account of their connective tissue sheath (Glisson's capsule).

In the *hepato-duodenal ligament* the common bile duct lies most anteriorly and to the right, the hepatic artery with the nerves to the liver anteriorly and to the left, and behind these is the portal vein. In addition to some connective tissue, rich in fat, the two peritoneal layers of the lesser omentum also enclose in this region the *hepatic lymph nodes* (lymphoglandulae).

The Gall Bladder, *vesica fellea.*

In the *gall bladder (vesica fellea)* one may distinguish the *fundus* from the more slender *neck (collum)*, which passes gradually into the cystic duct. Between the two is the *body (corpus)*.

The mucous membrane of the gall bladder even in the distended condition shows small folds, which unite to give a fine net-like appearance to the inner surface.

The *cystic duct* is a short, irregular cylindrical canal which unites with the hepatic duct in the neighborhood of the porta to form the common bile duct *(ductus choledochus)*. Its mucosa is raised into peculiar folds, which have a somewhat spiral course and form a *spiral valve* (Heister's).

The surface of the gall bladder which is not in contact with the liver is covered by peritoneum and the portion of the fundus that projects beyond the anterior border of the liver is completely enclosed by peritoneum.

The Digestive Organs. The Pancreas.

The Pancreas.

The *pancreas* is a flat, elongated, lobed gland, situated transversely on the posterior body wall in front of the upper lumbar vertebrae. It presents three not clearly defined parts; the *head (caput),* the *body (corpus)* and the *tail (cauda).* The head lies in the horse-shoe shaped loop of the duodenum and is the broadest part of the gland. It almost completely fills the space enclosed by the duodenal loop and sends backwards and to the left a special curved process, the *uncinate process* (Fig. 409), which hooks around the superior mesenteric vein as this lies behind the pancreas in a groove, the *pancreatic incisure.* This groove separates the head of the gland from the body, forming a neck or isthmus.

The *body (corpus)* is the narrower, principal part of the gland and the *tail (cauda)* is its left end, usually extending to the spleen and being somewhat pointed. Three surfaces may be recognized in the pancreas, of which the *inferior* is small and is to be seen only on the body and even there is not clearly defined. The two principal surfaces, the *anterior* and *posterior,* are broad; the strongly rounded borders are superior, anterior and posterior. The anterior surface is covered by the peritoneum of the bursa omentalis, but the posterior surface is without a peritoneal investment and a part of the anterior surface of the head and the uncinate process also have no peritoneal covering.

The anterior surface of the pancreas is not flat, but towards the right is distinctly convex, where it rests upon the bodies of the vertebrae and on the descending aorta in front of these; towards the left, on the other hand, it is distinctly concave as the result of its relations to the concave posterior surface of the stomach, this relation rendering it concave in the sagittal direction also. The anterior surface of the pancreas has therefore a saddle-like, if not an exactly saddle-shaped, form. The strongest projection of the upper border at the left edge of the convex portion is termed the *tuber omentale* and corresponds essentially to the lesser curvature of the stomach; it lies behind the bursa omentalis.

The *pancreatic duct* (Wirsung's) traverses the whole length of the gland, becoming larger from the tail to the head by receiving branches that enter it almost at right angles. It lies almost in the axis of the gland. In the upper part of the head of the gland there is an *accessory pancreatic duct,* whose relations are very variable. Usually it opens by a special orifice into the descending portion of duodenum, but it is always united by a transverse branch to the main duct and may open into this only.

Fig. 407. The pancreas and the greater part of the duodenum, from in front. ($^1/_1$)
The pancreatic ducts are exposed by cutting away the substance of the gland from in front. * = opening of the greater pancreatic and common bile ducts.

Fig. 408. The head of the pancreas and the duodenum with the common bile duct. ($^1/_2$)
and splenic (lienal) artery, from behind. * = boundary of peritoneum. and the portal vein

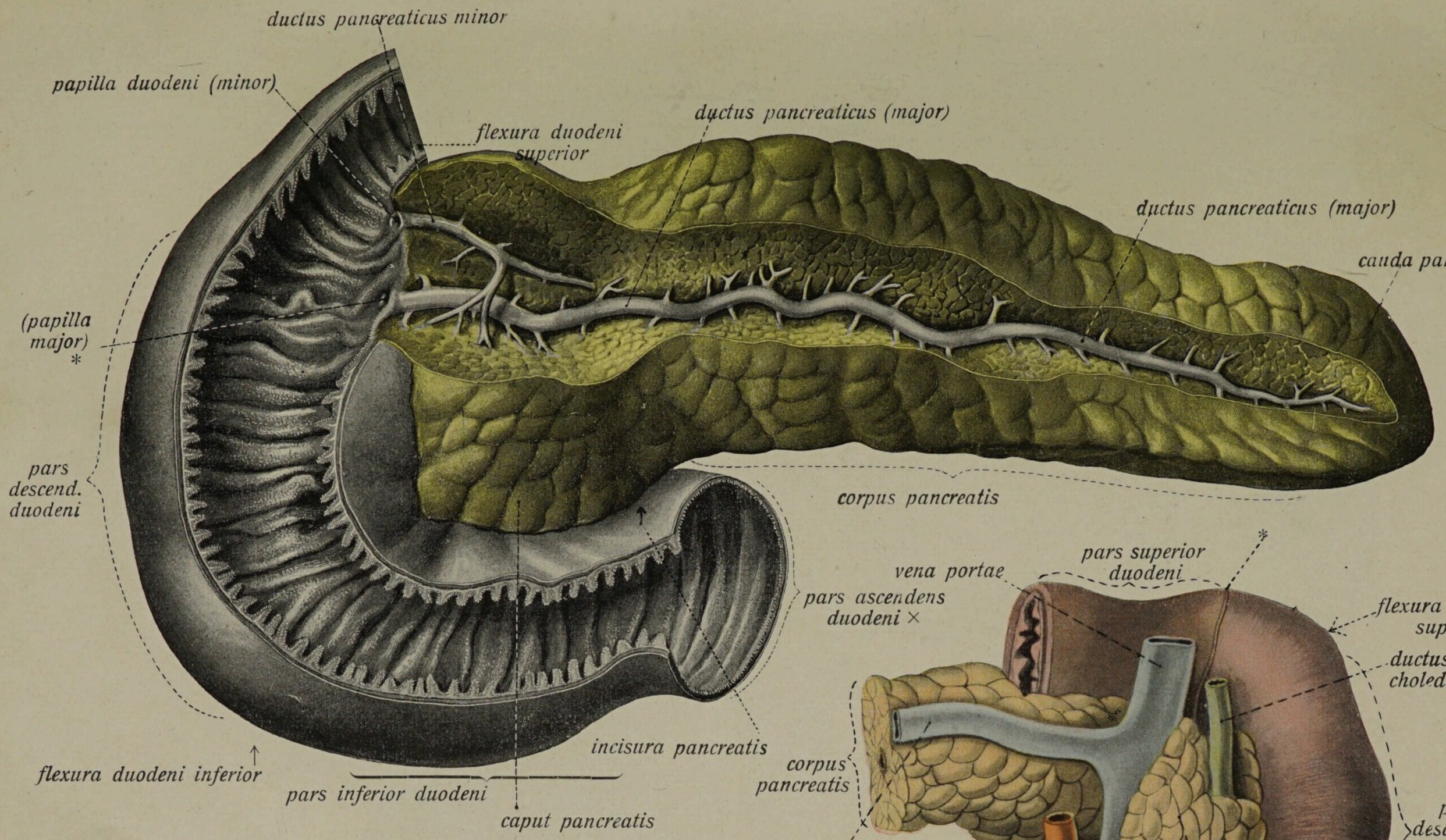


Fig. 407.

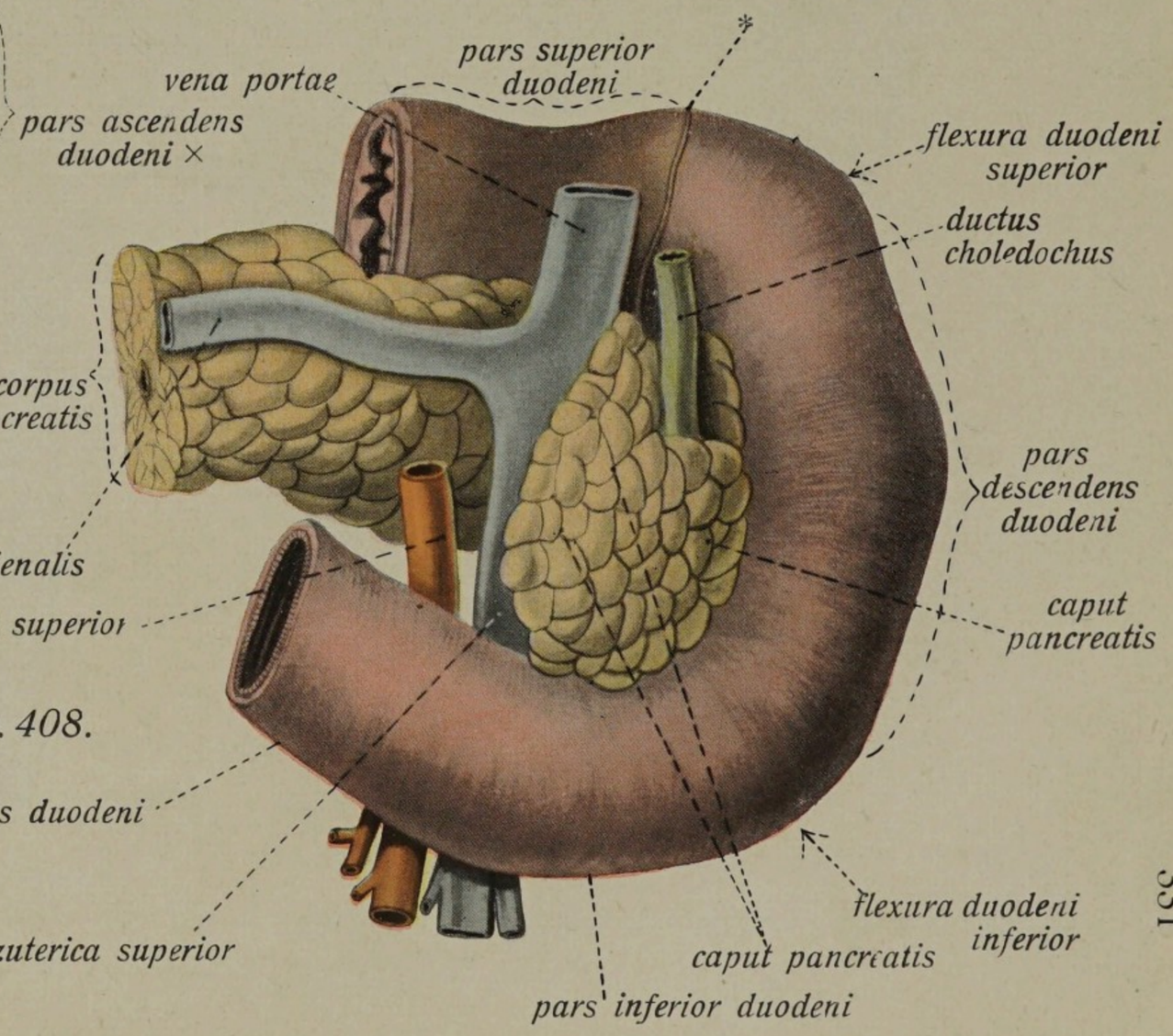


Fig. 408.

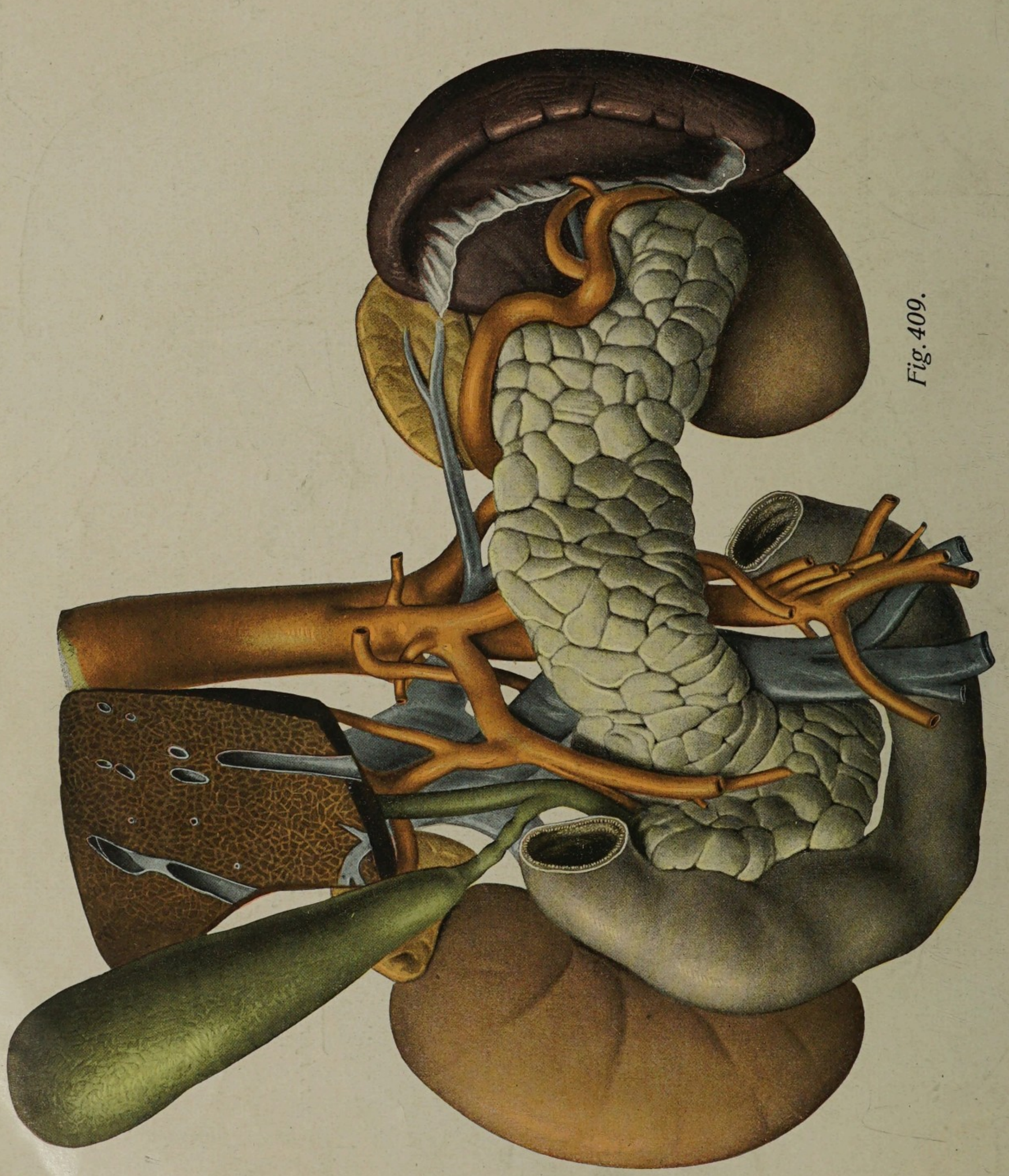


Fig. 409.

Figs. 409 and 410. The duodenum, pancreas, spleen, kidneys, suprarenal bodies, gall bladder (with a piece of the liver), aorta and inferior vena cava in their relative

Figs. 409 and 410. The duodenum, pancreas, spleen, kidneys, suprarenal bodies, gall bladder (with a piece of the liver), aorta and inferior vena cava in their relative positions. ($^3/_5$)

The spleen is drawn away from the left kidney to show its renal surface. The peritoneum is removed except over the spleen. (The pancreas is lower than usual.)

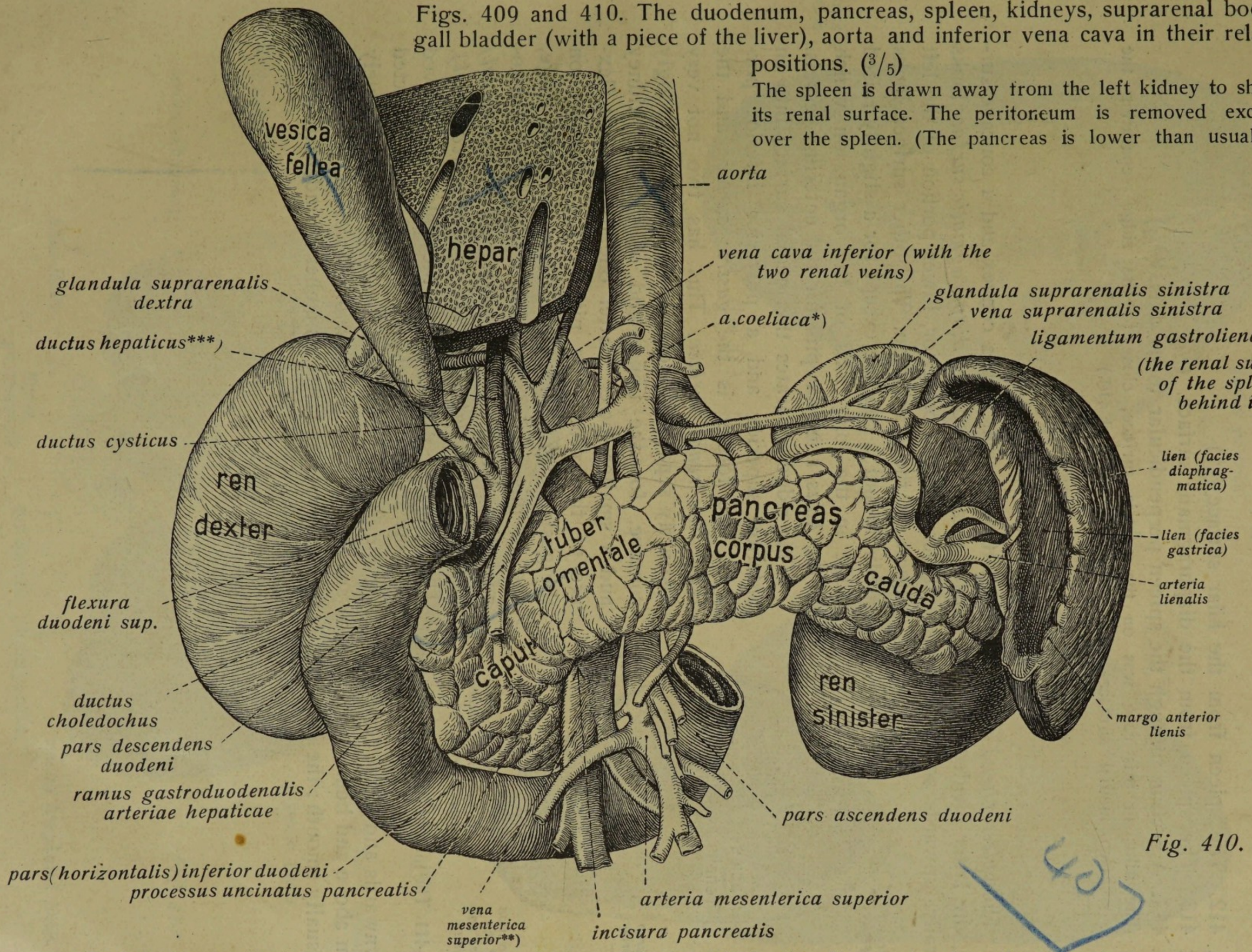


Fig. 410.

*) Behind this is the left renal vein; passing downward is the splenic (lienal) artery and to the right the hepatic artery.
**) In the prolongation of this, above the pancreas, is the portal vein.
***) To the right is the hepatic artery. Between and behind both is the portal vein and behind this the inferior vena cava with the right renal vein.

Fig. 412. The spleen from the hilar surface (3/4)
Fig. 413. The spleen from the diaphragmatic surface. (3/4)
Fig. 414. A section through the spleen perpendicular to its axis. (5/4)
The hilus in this case was on the gastric surface, close to the ridge separating the two medial surfaces. (see also Fig. 409 and 410.)

The Spleen, *lien.*

The *spleen (lien)* is a somewhat flattened organ with a convex and a concave surface, the latter divided into subordinate areas. The convex *diaphragmatic surface* looks laterally, upwards and backwards and occupies the posterior, lower portion of the left cupola of the diaphragm. The other surface looks medially and is concave except for a slightly raised ridge in the long axis of the organ, on which is the *hilus* i. e. the pits for the entering vessels.

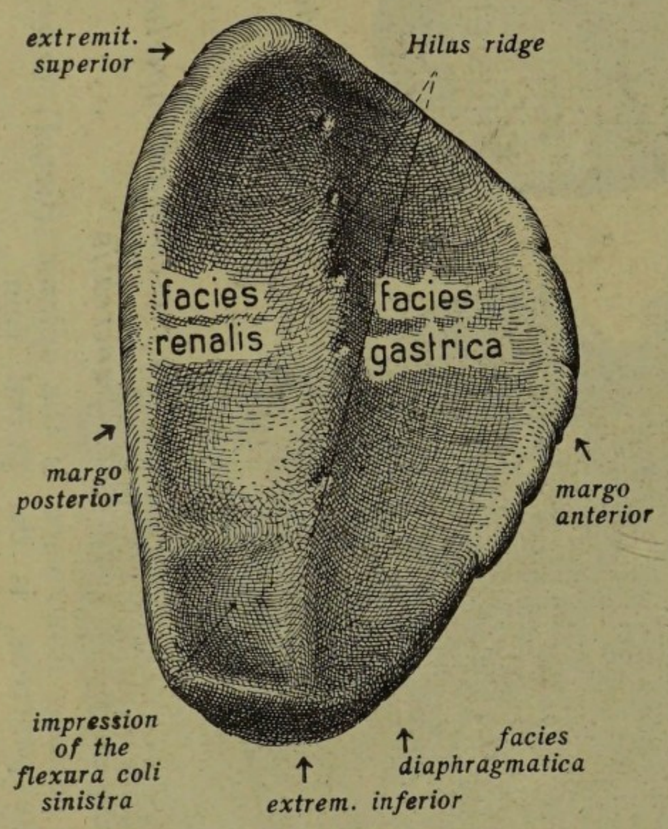


Fig. 411. The medial surface of the spleen.

This ridge separates the medial surface into an anterior superior and a posterior inferior portion. The former is the *gastric surface* and the latter the *renal surface*. This has two not very distinctly separated areas, an upper, more strongly concave, for the upper end of the left kidney and a smaller lower, flatter one for the left flexure of the colon. The pits of the hilus are on the gastric surface, more or less close to the ridge, and in this region are also attached the peritoneal ligaments, the *gastro-splenic (gastro-lienal)* and the *pancreatico-splenic (pancreatico-lienal)*. The *superior extremity* of the spleen is curved medianwards; the *inferior extremity* is directed downwards and to the left. The axis joining these two extremities is directed obliquely from above and behind, downwards and forwards. The *posterior border* of the spleen is usually smooth; the *anterior border* is sharper and has a number of indentations.

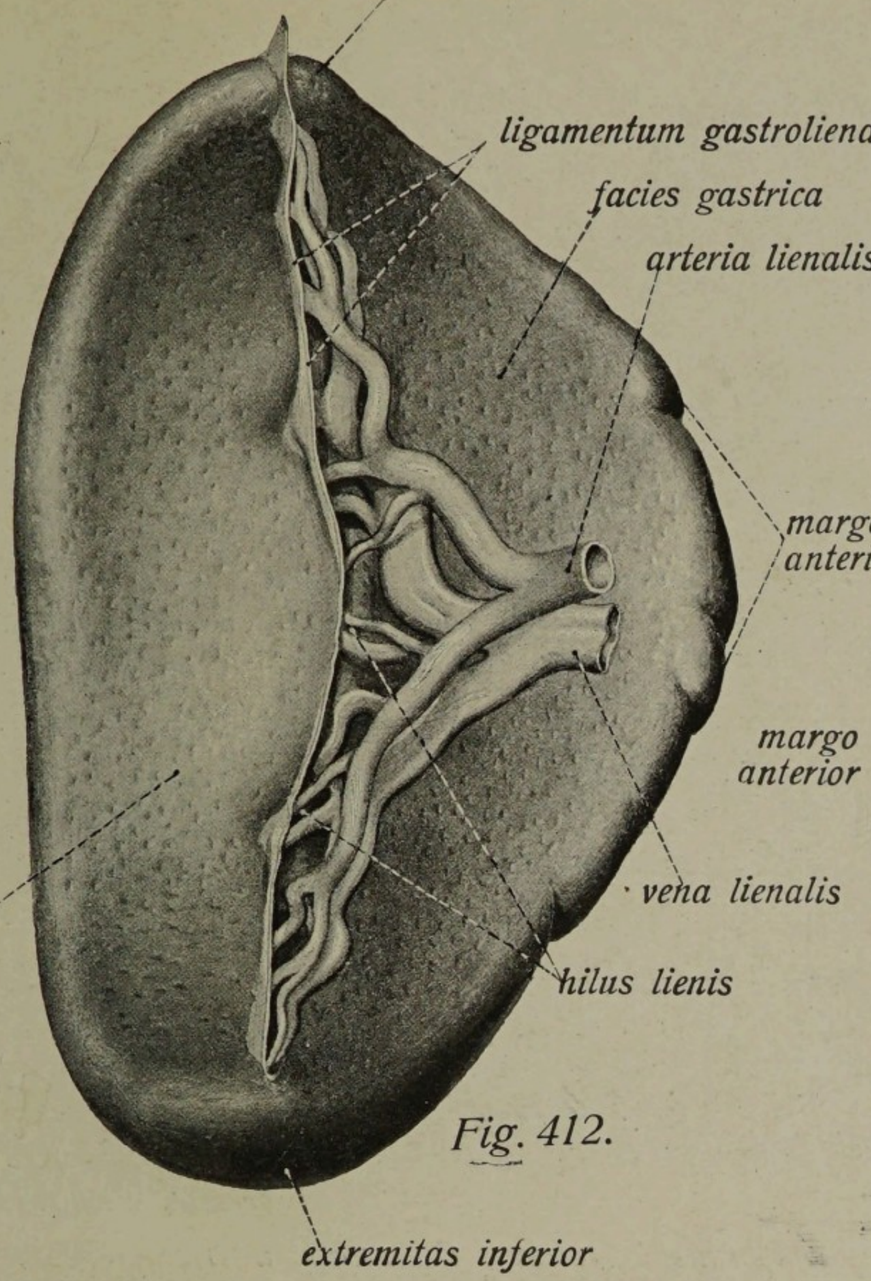


Fig. 412.

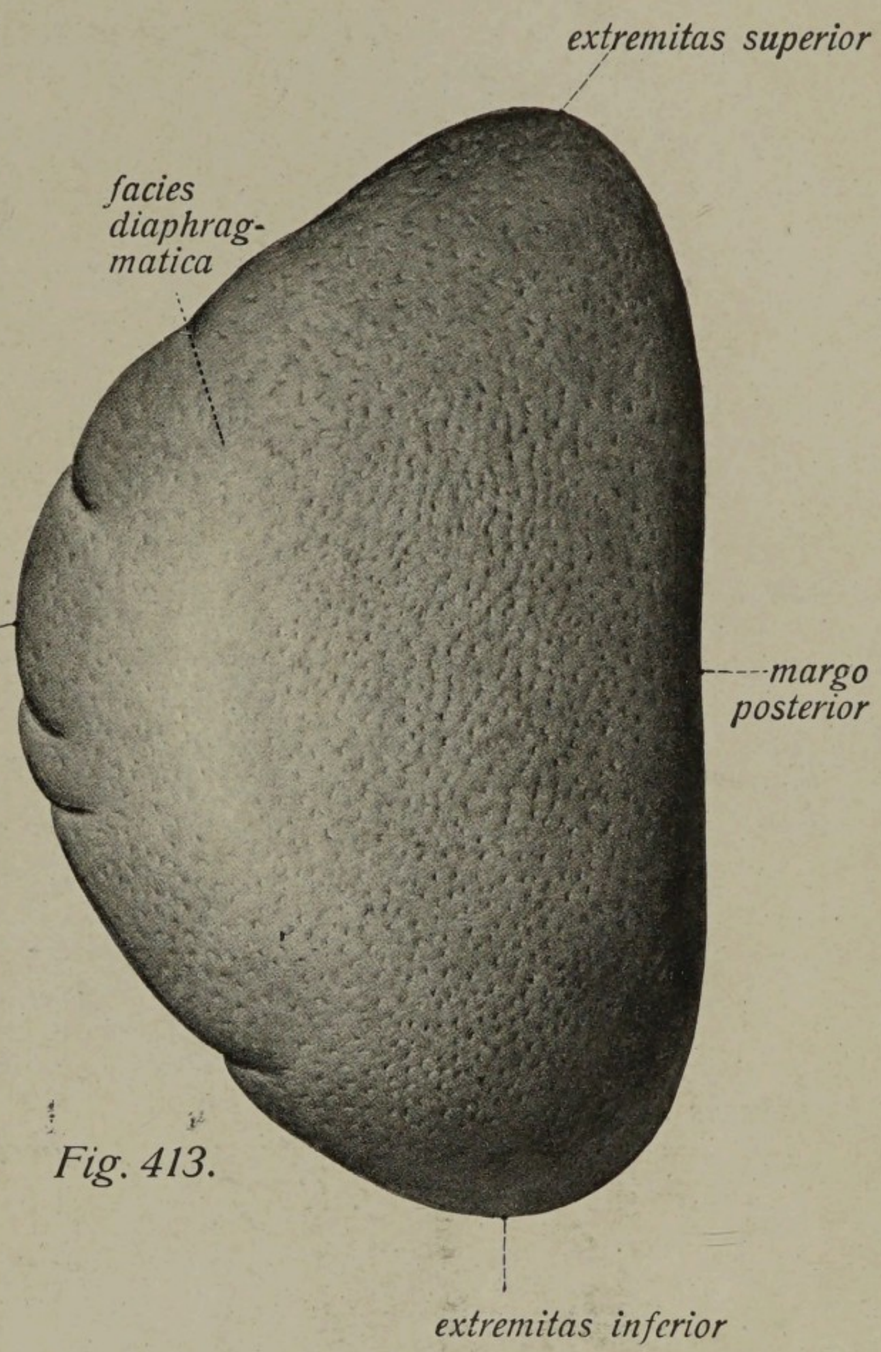


Fig. 413.

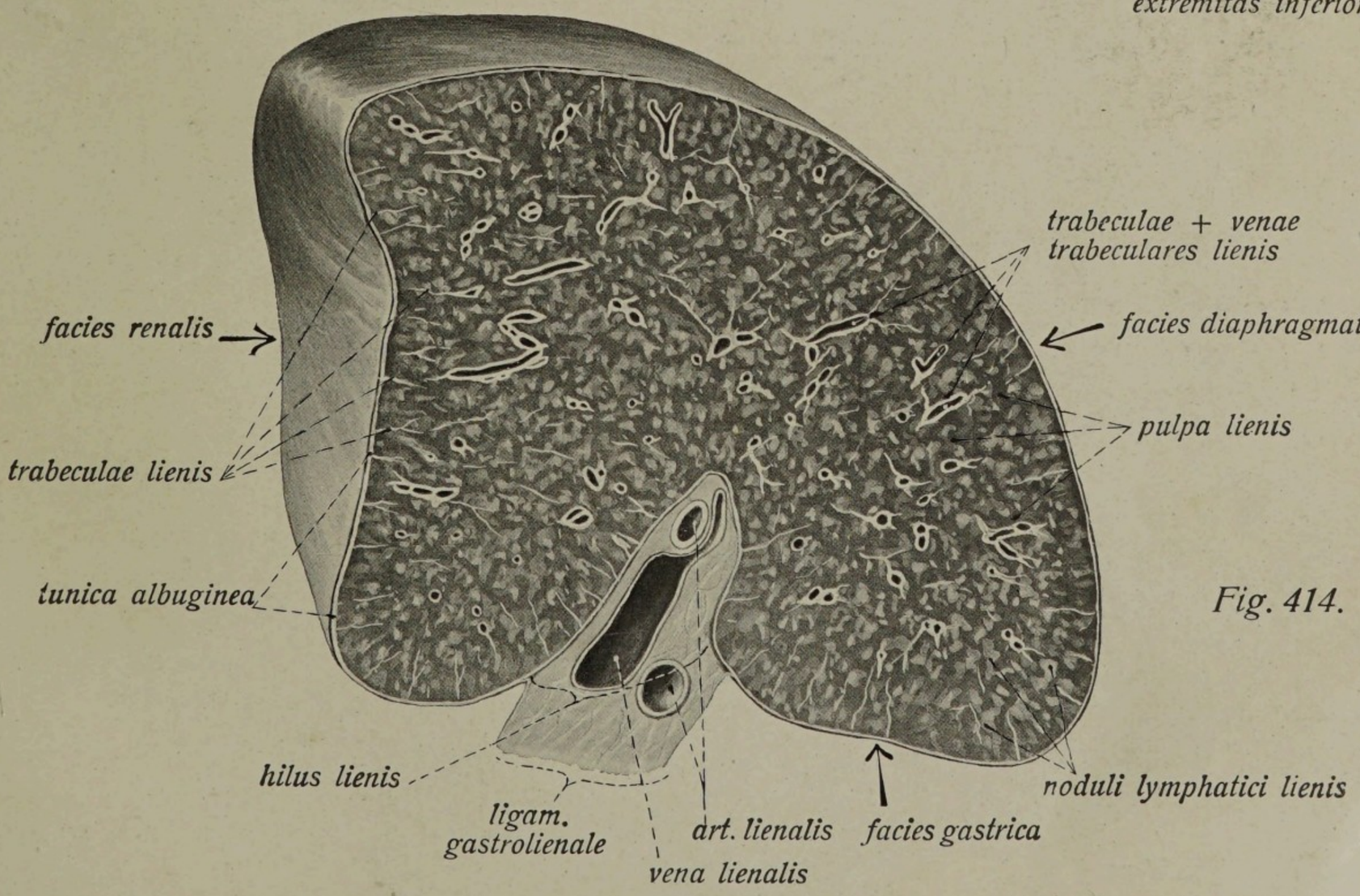


Fig. 414.

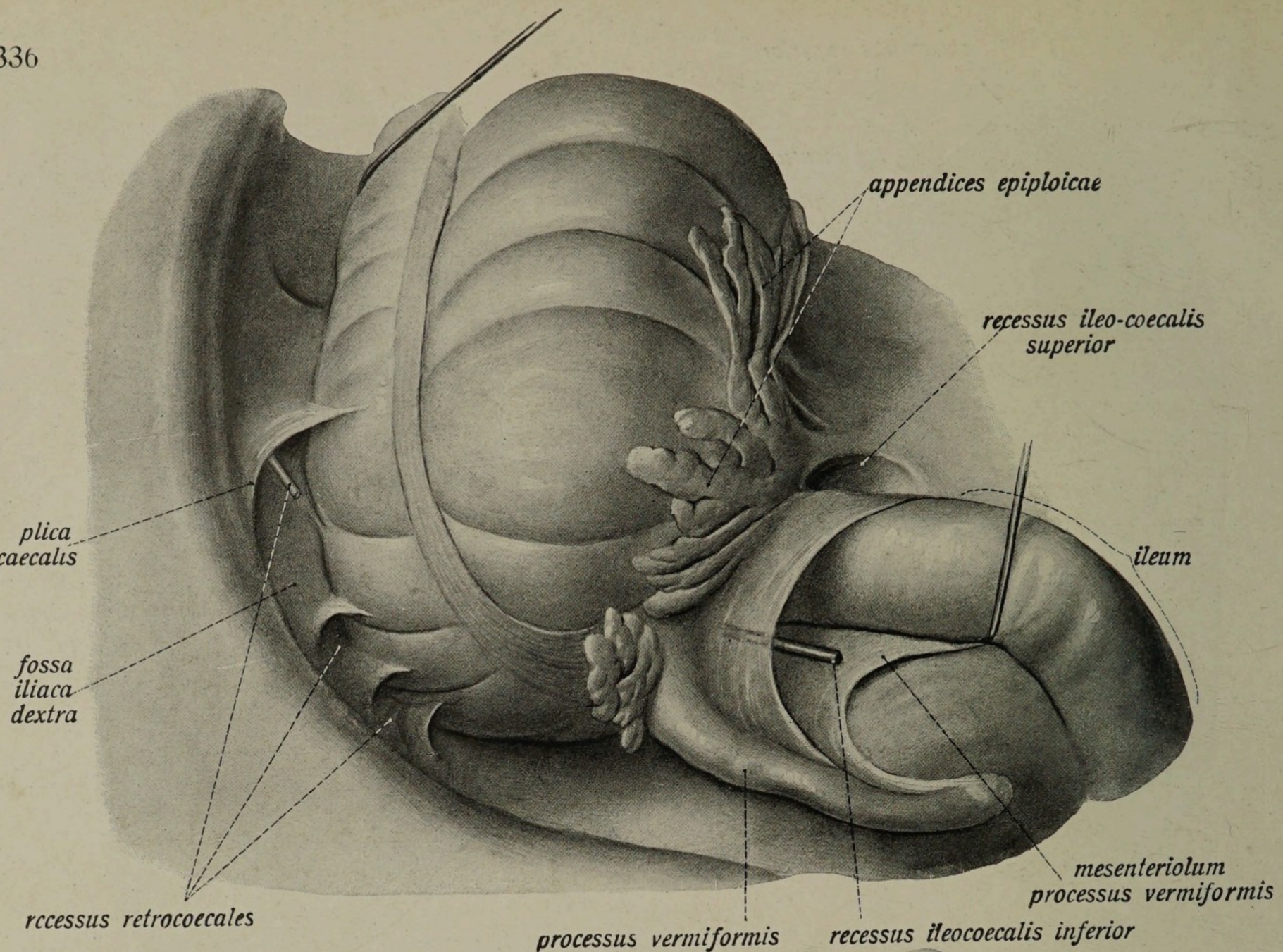


Fig. 415.

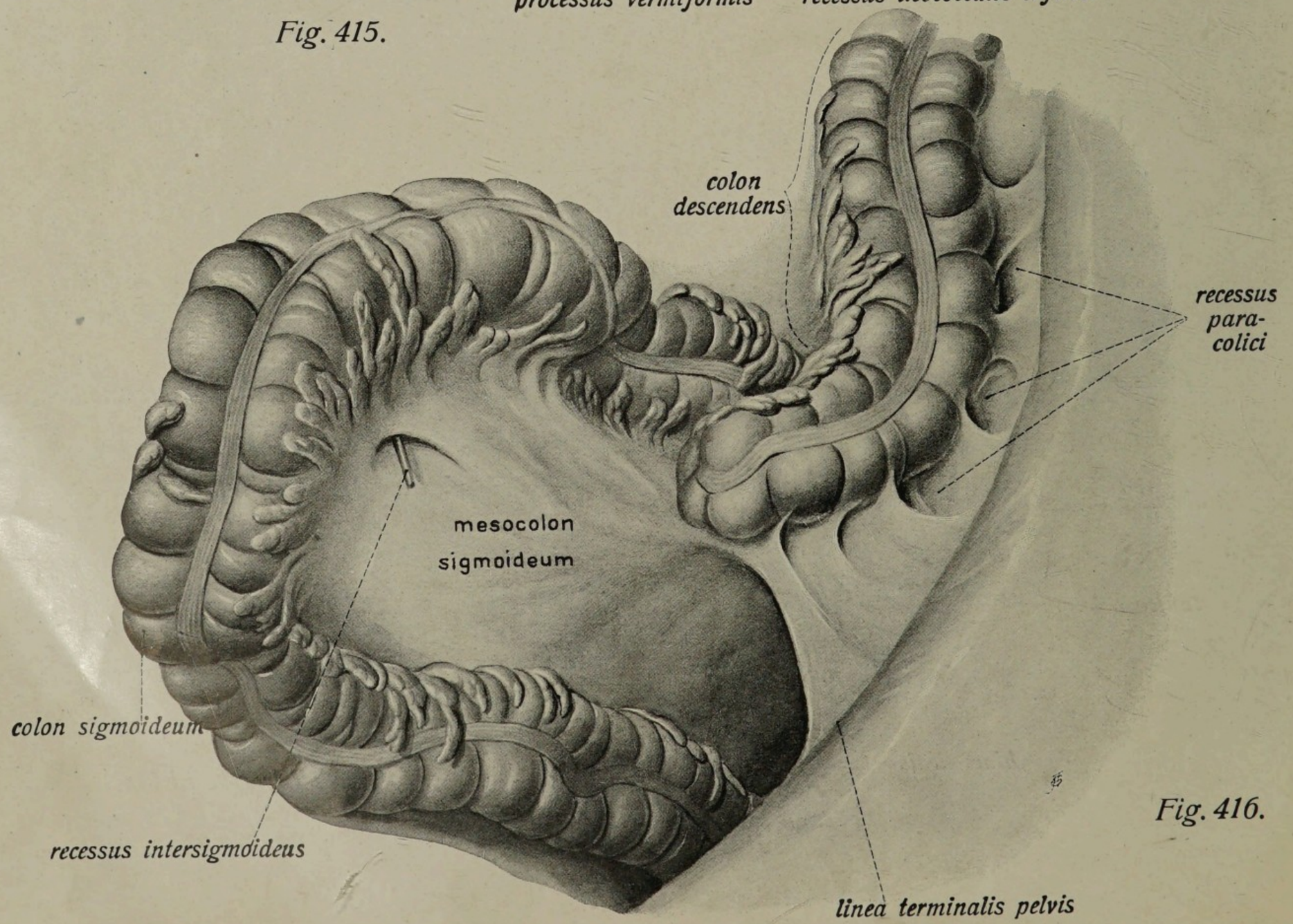


Fig. 416.

The Digestive Organs. The Peritoneum.

Fig. 415. The caecum with the peritoneal folds and pouches in its neighborhood. ($^1/_1$)
A sound is placed in the inferior ileocaecal recess.

Fig. 416. The descending and sigmoid colons with the neighboring peritoneal folds and pouches. ($^1/_1$)
The sigmoid mesocolon is made tense, since the colon is drawn upwards and to the right.

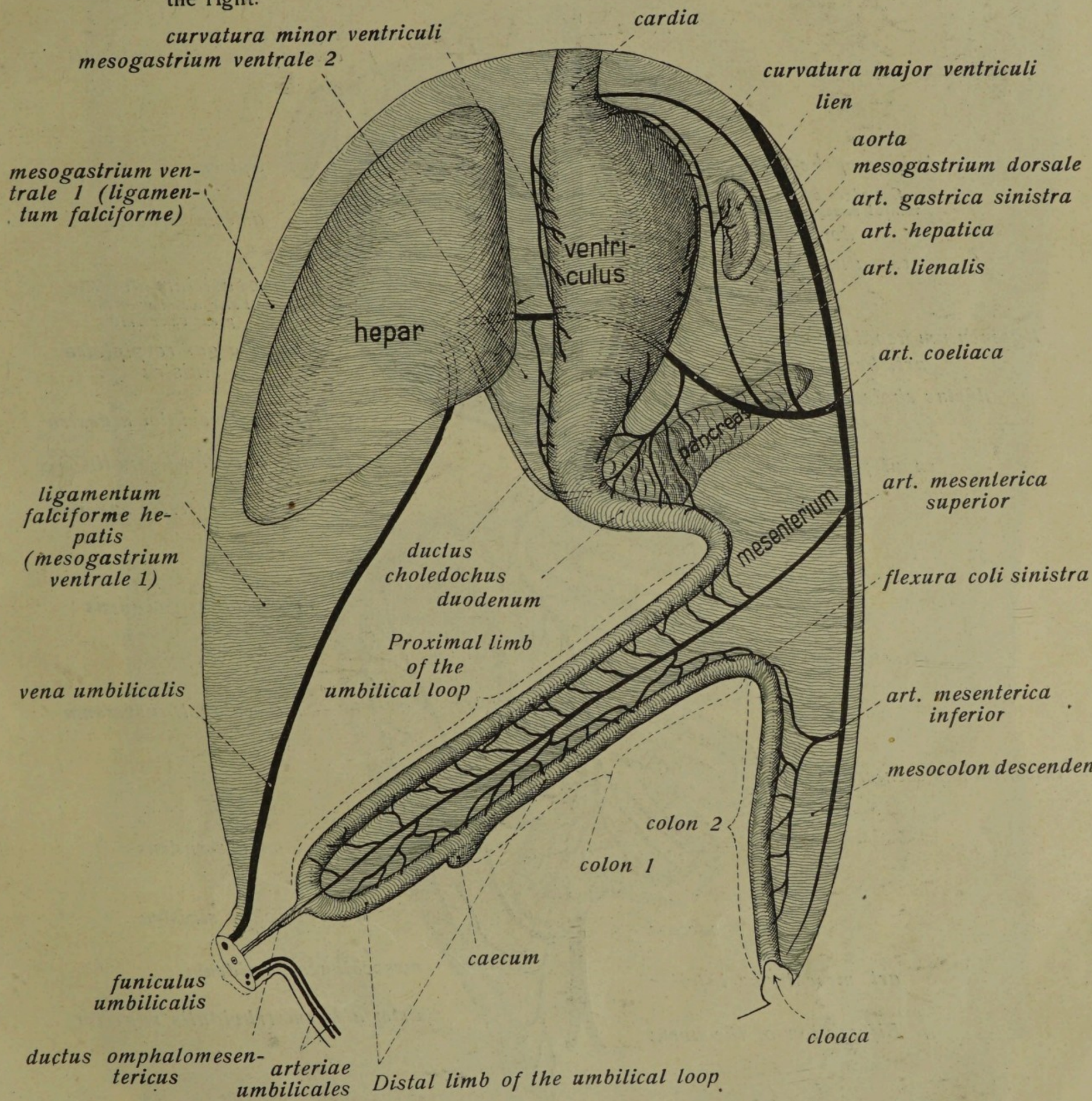


Fig. 417. The first stage in the development of the intestine and the peritoneum. From the side (schematic).
colon 1 = the later ascending and transverse colons; colon 2 = the later descending and sigmoid colons and rectum. In the mesogastricum 1 indicates the portion in front of the liver and 2 the portion behind it. The vessels are black, the peritoneum gray.

The Digestive Organs. The Peritoneum. (Cont.)

Plate 6.

The abdominal contents as seen on opening the cavity from in front. The great Omentum. ($^2/_3$) The abdominal cavity is opened by crucial incisions. The skin and muscle flaps have been cut away above the costal arch; below they are reflected.

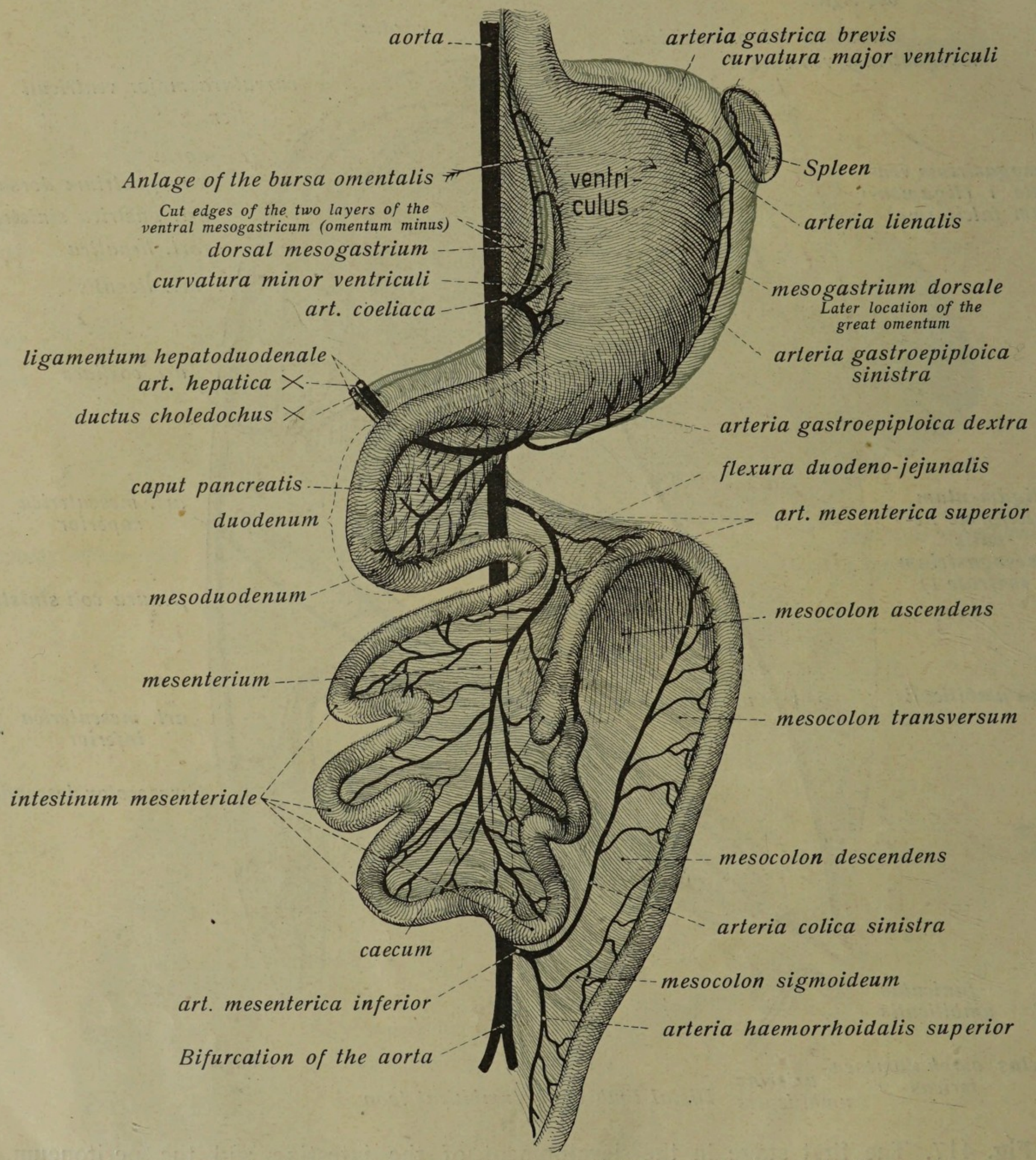
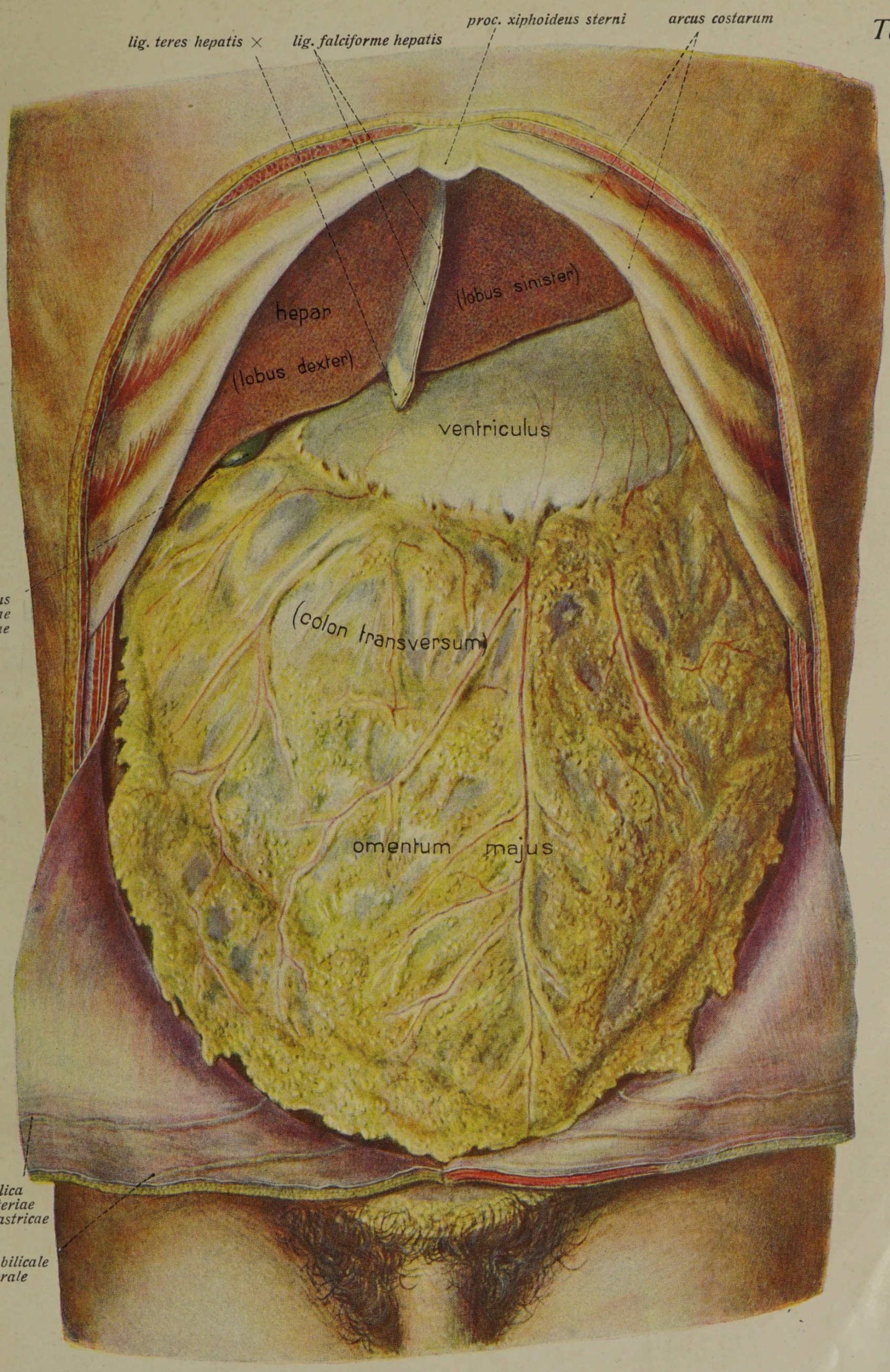


Fig. 418. The second stage in the development of the intestines and the peritoneum. From in front (schematic).

The liver is removed and the two layers of the ventral mesogastrium (lesser omentum) are cut. The vessels are black, the peritoneum gray.


lig. teres hepatis
lig. falciforme hepatis
proc. xiphoideus sterni
arcus costarum
hepar
(lobus dexter)
(lobus sinister)
ventriculus
fundus vesicae felleae
(colon transversum)
omentum majus
plica arteriae epigastricae
lig. umbilicale laterale

The Digestive Organs. The Peritoneum. (Cont.)

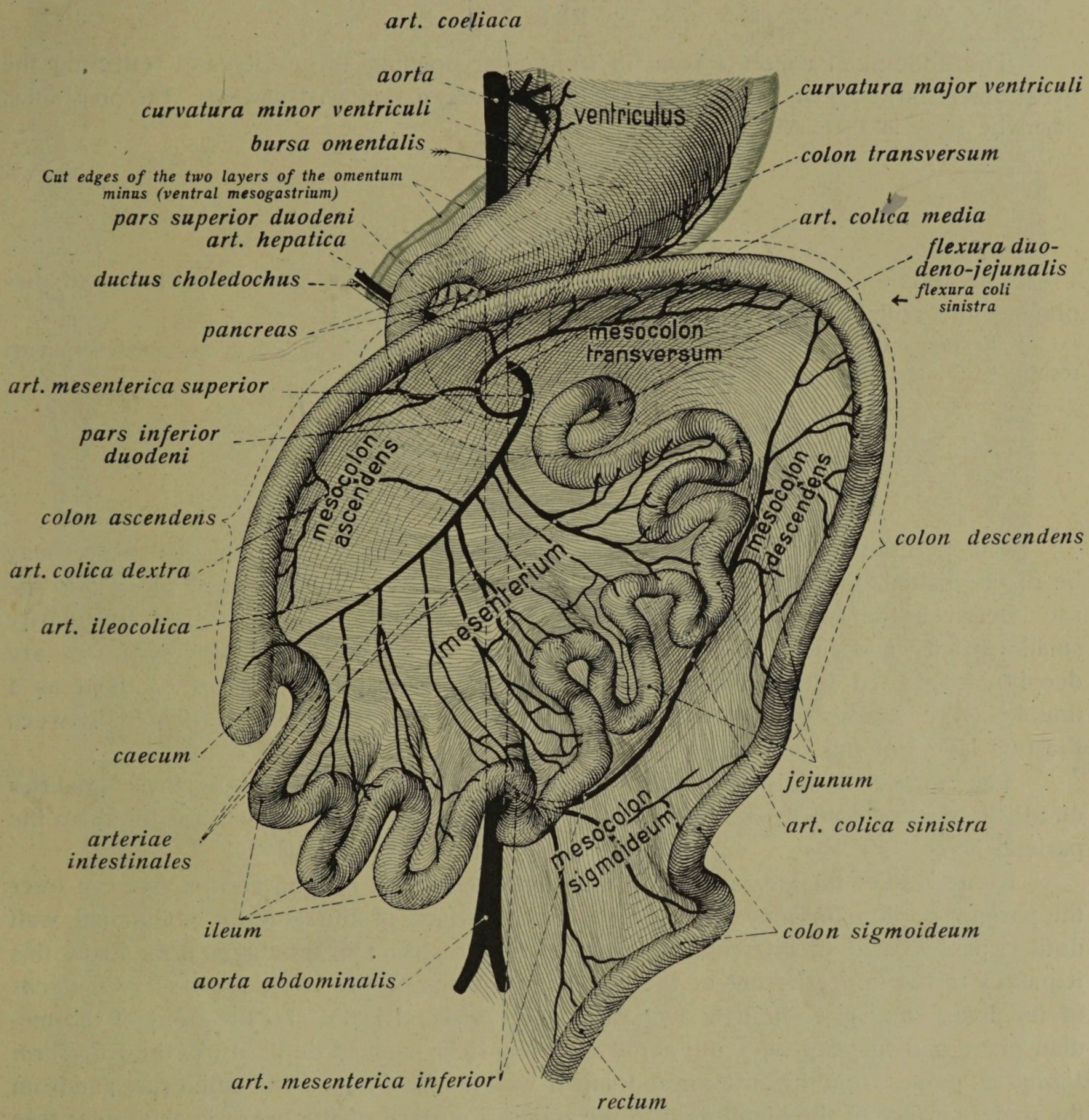


Fig. 419. The third stage in the development of the intestines and peritoneum. From in front (schematic). Beginning of the formation of the final arrangement. The large intestine has surrounded the small and so has assumed its horse-shoe shape. The small intestine is greatly elongated and contorted; the stomach has attained its final position.
Preparation etc. as in Fig. 418.

The Digestive Organs. The Peritoneum. (Cont.)

Plate 7.

The abdominal contents from in front after opening the cavity and reflecting the great omentum. ($^2/_5$) The transverse colon is also drawn somewhat upwards. The preparation otherwise is as in Plate 6.

Plate 8.

The abdominal organs from in front after reflecting the great omentum and displacing the coils of the small intestine to the right. ($^2/_5$)

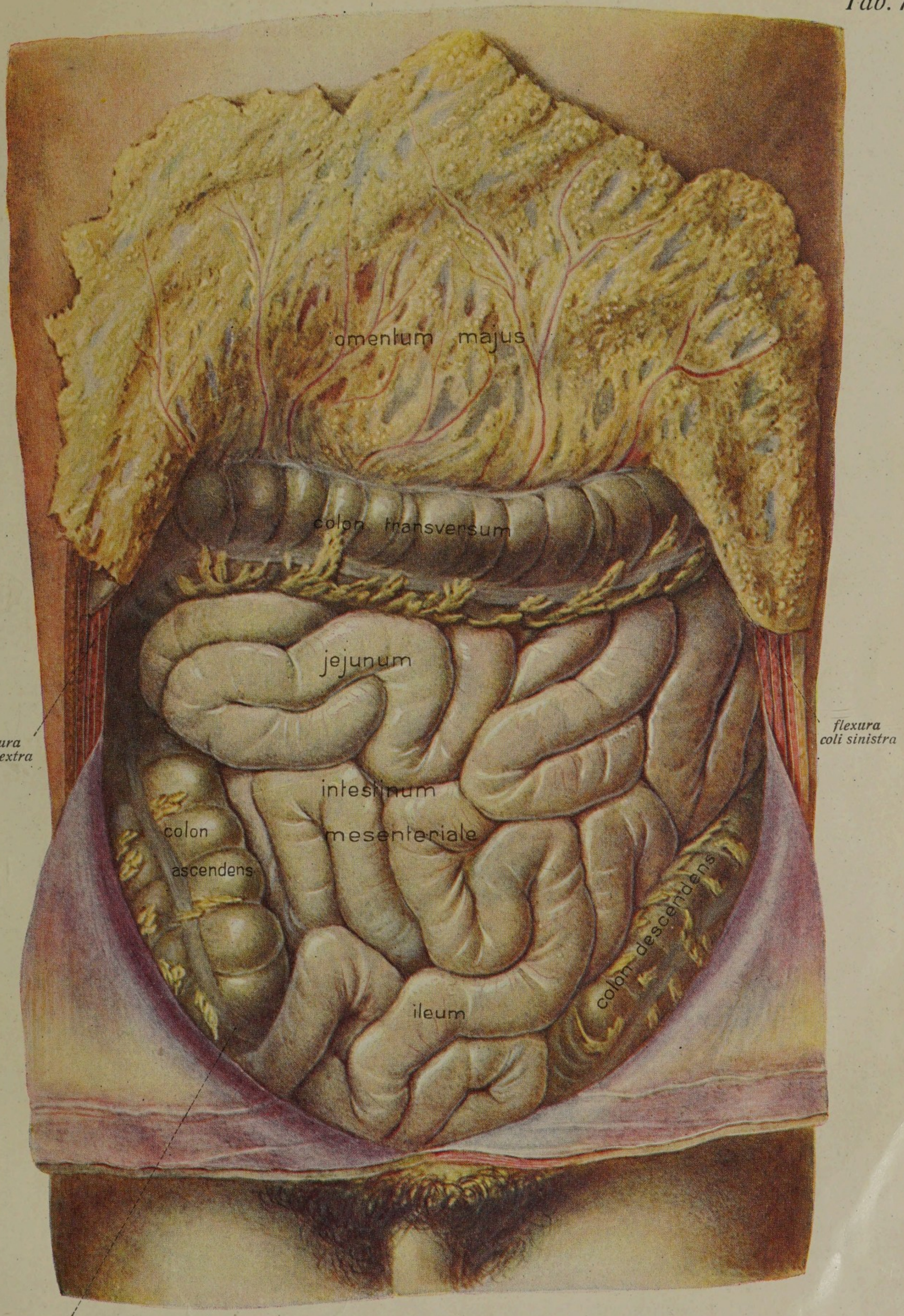
The preparation otherwise is as in Plates 6 and 7. A sound is placed in the duodeno-jejunal recess. * = ascending portion of the duodenum.

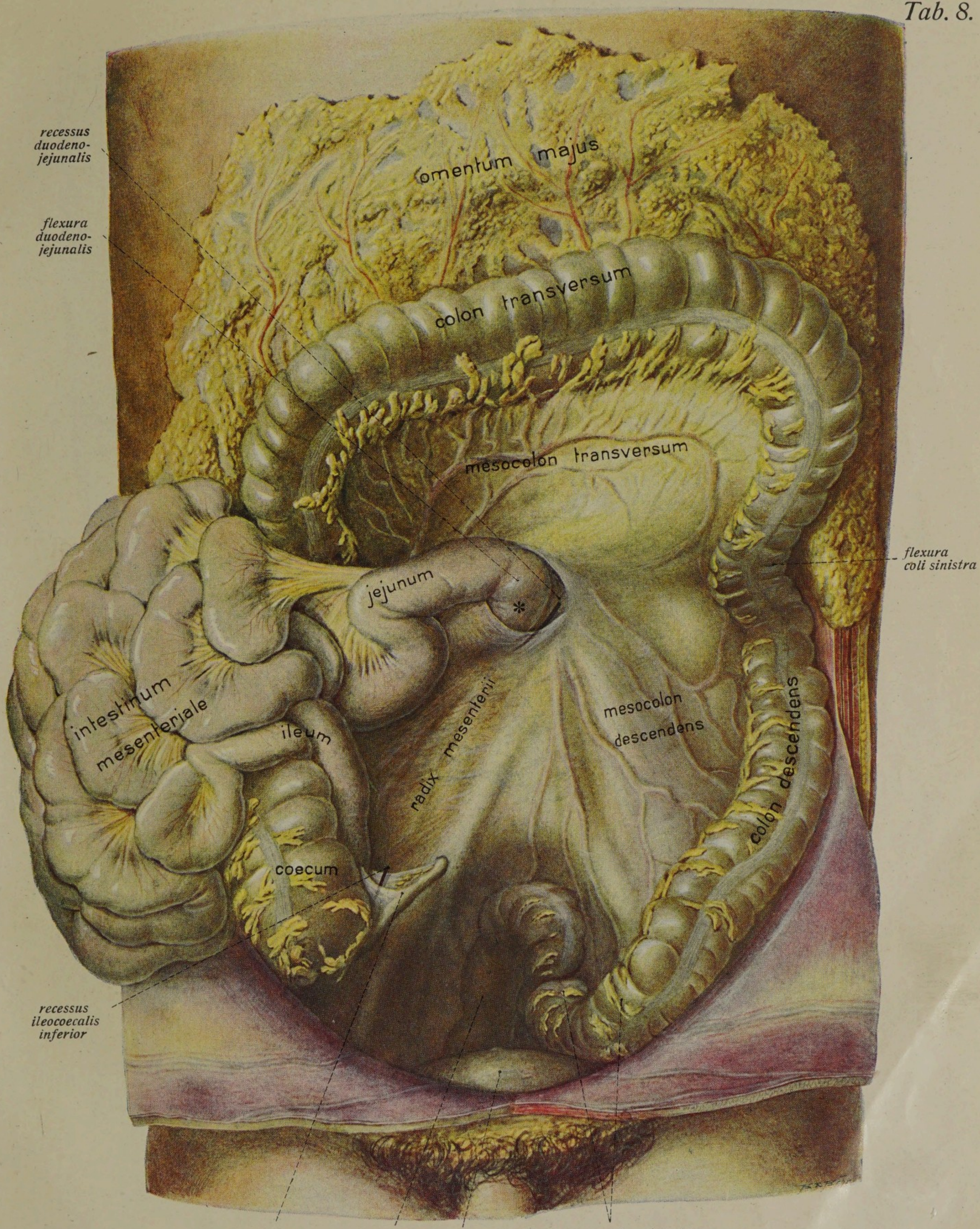
The Peritoneum.

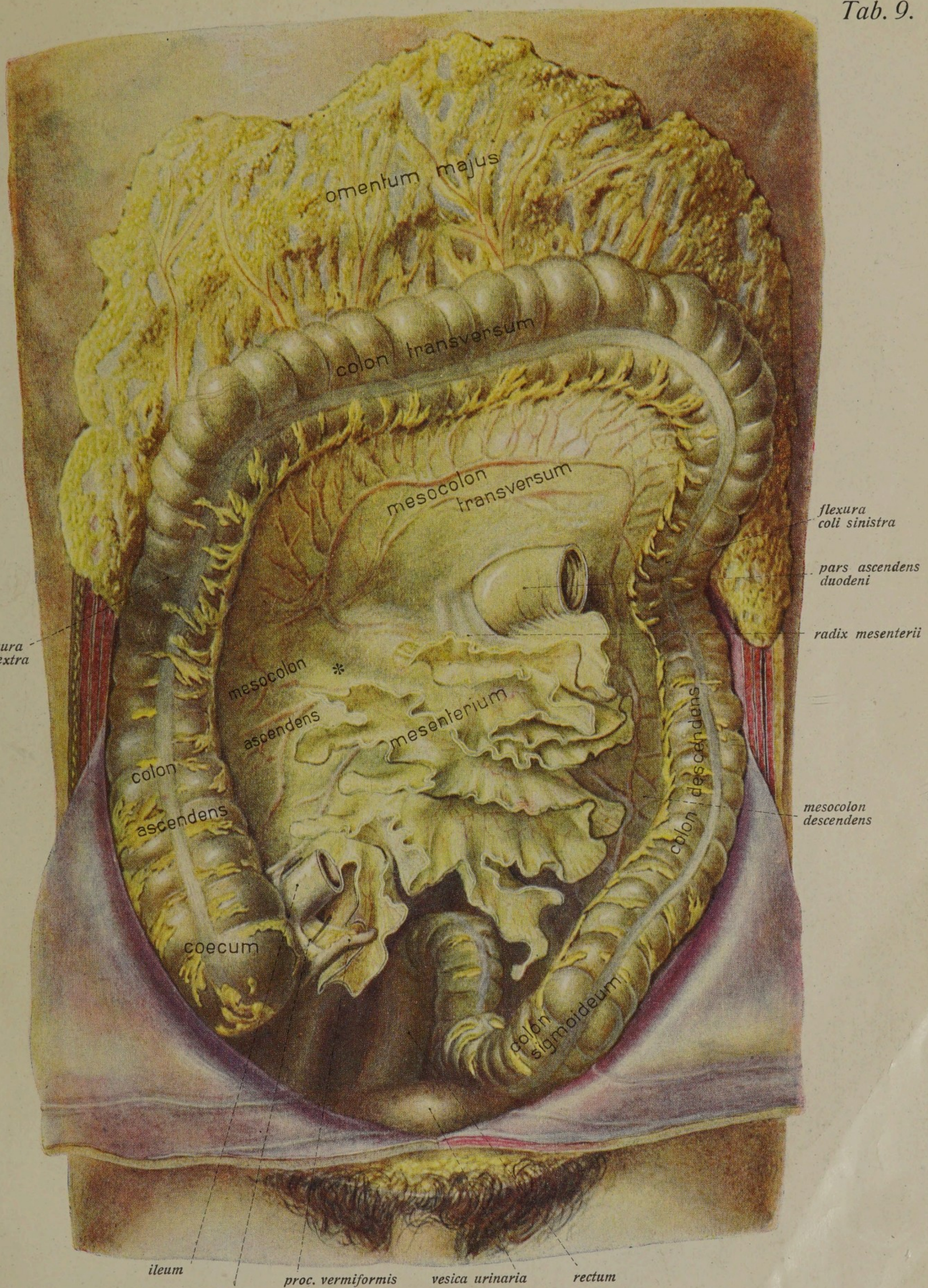
The peritoneum is a closed sac in which a parietal and a visceral layer may be distinguished, the latter covering the abdominal viscera that are invaginated into the sac. Between the two layers there is a cleft-like, complicated cavity, of extraordinarily small capacity and filled with a minimal amount of serous fluid. Where viscera are deeply invaginated into the peritoneal cavity the visceral layer passes to them as a double-layered *mesentery*, the nutrient vessels and the nerves being contained between the two layers of this.

The surface of the peritoneum is smooth and shining and confers these qualities on all the viscera it encloses, as well as on the abdominal walls, which are lined by the parietal layer.

If one studies the arrangement of the peritoneum in a median section one can trace the parietal peritoneum upwards upon the inner surface of the anterior abdominal wall until it passes without interruption upon the under surface of the diaphragm. From this it passes to the upper border of the posterior surface of the liver, *(coronary ligament* of the liver), and is continued over this as the visceral layer. To the right of the median plane and forming an acute angle with it a sickle-shaped duplicature, the *falciform ligament*, passes from the anterior abdominal wall (as far down as the umbilicus) and from the under surface of the diaphragm to the superior surface of the liver; in the lower free border of this duplicature the *ligamentum teres*, the obliterated umbilical vein, runs from the umbilicus to the under surface of the liver. Both layers of the falciform ligament pass over into the coronary ligament.


omentum majus
colon transversum
jejunum
flexura coli dextra
flexura coli sinistra
intestinum mesenteriale
colon ascendens
colon descendens
ileum
coecum


recessus duodeno-jejunalis
flexura duodeno-jejunalis
omentum majus
colon transversum
mesocolon transversum
flexura coli sinistra
jejunum
*
intestinum mesenteriale
ileum
radix mesenterii
mesocolon descendens
colon descendens
coecum
recessus ileocoecalis inferior
processus vermiformis
rectum
vesica urinaria
colon sigmoideum


omentum majus
colon transversum
mesocolon transversum
flexura coli sinistra
pars ascendens duodeni
radix mesenterii
flexura coli dextra
mesocolon ascendens
mesenterium
colon ascendens
colon descendens
mesocolon descendens
coecum
colon sigmoideum
ileum
recessus ileocoecalis inferior
proc. vermiformis
vesica urinaria
rectum

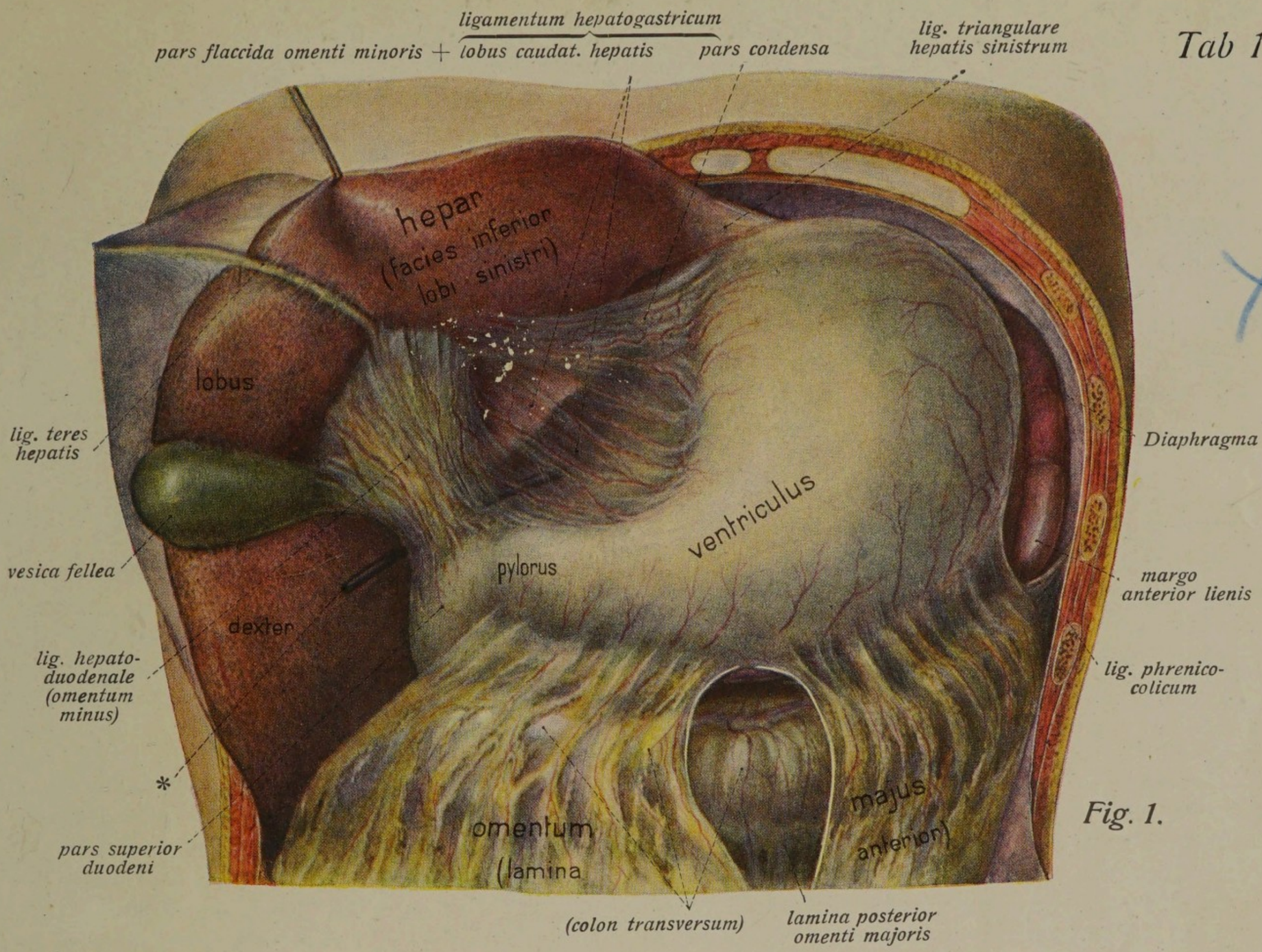

ligamentum hepatogastricum
pars flaccida omenti minoris + lobus caudat. hepatis
pars condensa
lig. triangulare hepatis sinistrum
hepar (facies inferior lobi sinistri)
lobus
lig. teres hepatis
vesica fellea
dexter
lig. hepato-duodenale (omentum minus)
*
pars superior duodeni
pylorus
ventriculus
Diaphragma
margo anterior lienis
lig. phrenico-colicum
majus
omentum (lamina anterior)
(colon transversum)
lamina posterior omenti majoris

Fig. 1.

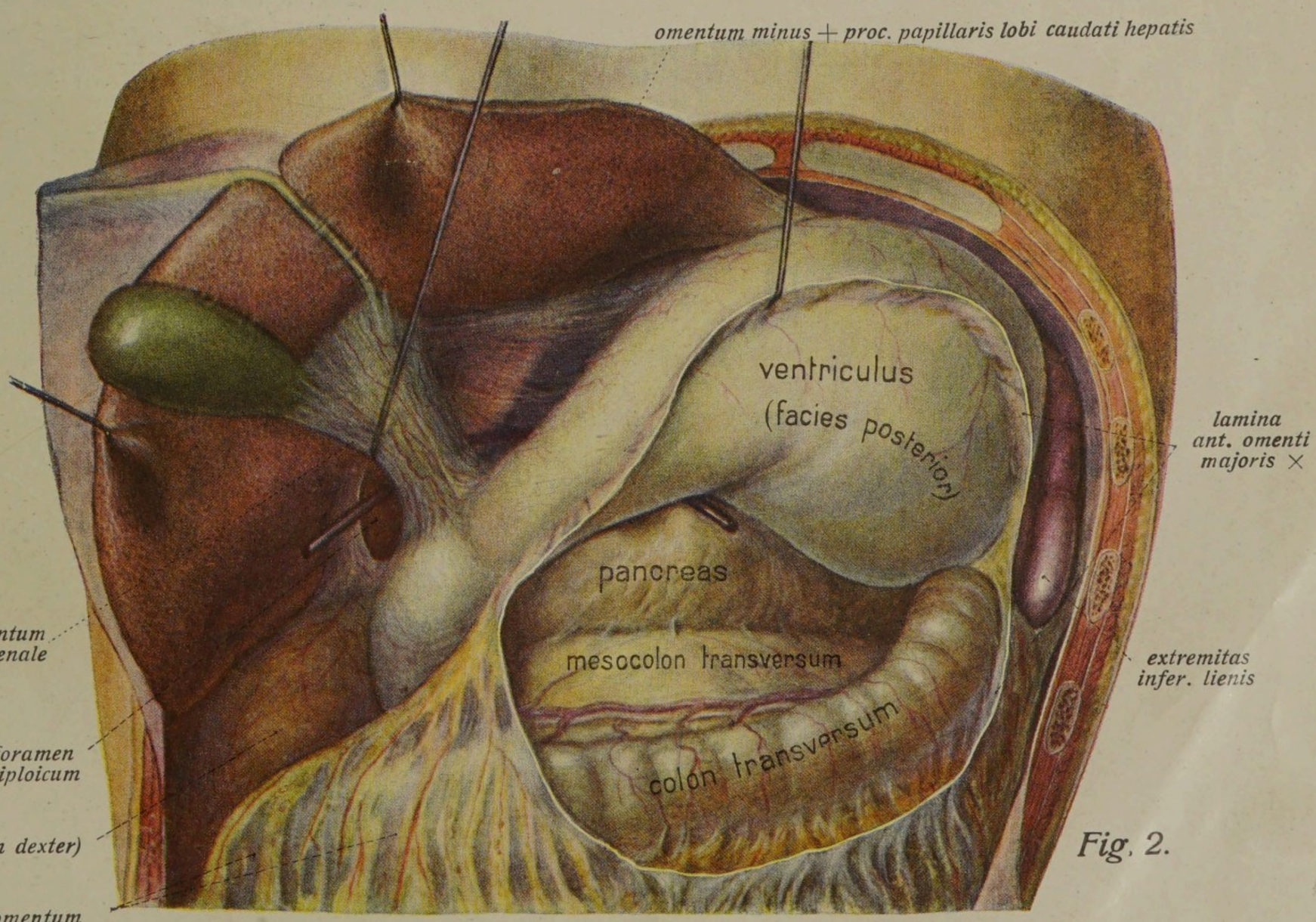

omentum minus + proc. papillaris lobi caudati hepatis
ventriculus (facies posterior)
lamina ant. omenti majoris ×
pancreas
mesocolon transversum
colon transversum
ligamentum hepatoduodenale
foramen epiploicum
(ren dexter)
omentum majus
extremitas infer. lienis

Fig. 2.

The Digestive Organs. The Peritoneum. (Cont.)

Plate 9.

The position of the large intestine in the abdominal cavitiy. ($^2/_5$) The small intestine has been cut away at the attachment of its mesentery, from the duodenum to the terminal part of the ileum. The transverse colon and great omentum have been drawn upwards. A sound has been placed in the inferior ileo-caecal recess. * = position of the retroperitoneal portion of the duodenum, at about the inferior flexure. On account of fat tissue in the mesentery the duodenum appears only as a slight convexity. (Compare also Plate 12.)

Plate 10.

Fig. 1. The upper portion of the abdominal cavity with the stomach, liver, spleen and lesser omentum. ($^2/_5$) The left lobe of the liver is drawn upwards and a sound (*) has been passed into the vestibule of the bursa omentalis, showing through the flaccid portion of the lesser omentum, as does also the papillary process of the caudate lobe of the liver. The anterior layer of the greater omentum (the gastro-colic ligament) is cut so that the inferior recess of the bursa omentalis is opened and one sees the transverse colon.

Fig. 2. The epiploic foramen and bursa omentalis. ($^2/_5$) The entire liver is drawn upwards, the hepatoduodenal ligament to the left to show the epiploic foramen and the stomach upwards, after cutting the gastro-colic ligament just below the greater curvature, thus opening into the bursa omentalis and exposing the pancreas. A sound is passed through the epiploic foramen and behind it is the hepato-renal ligament, made tense by raising the liver. This ligament passes over into the duodenal-renal ligament and thus with the hepato-duodenal ligament forms the boundary of the epiploic foramen. The sound is seen in the bursa omentalis through the flaccid portion of the lesser omentum, as is also the papillary process of the caudate lobe of the liver. At the isthmus of the bursa omentalis the sound appears again over the upper border of the pancreas (principal part of the bursa). The posterior surface of the stomach, covered by the peritoneum of the bursa omentalis, is seen over the greatest part of its extent.

The Peritoneum. (Cont.)

The liver is thus covered by peritoneum as far as the caudate lobe and on the under surface as far as the region of the porta; from there the peritoneum passes as the two layers of the *lesser omentum* to the lesser curvature of the stomach and to the upper surface of the superior portion of the duodenum (the *hepato-gastric* and the *hepato-duodenal ligaments).* In this manner the peritoneum reaches the stomach and the anterior layer of the lesser omentum is continued downwards over its anterior surface. From the greater curvature arise the anterior layers of the great omentum, an apron-like (quadruple) fold of peritoneum that hangs down over all the viscera of the lower part of the abdominal cavity (below the transverse colon and mesocolon). At the free border of the great omentum its anterior layer coming from the greater curvature of the stomach passes over into the posterior layer and this attaches above to the transverse colon. It is then continued as the lower layer of the transverse mesocolon to be attached to the posterior abdominal wall in an almost transverse line.

The Digestive Organs. The Peritoneum. (Cont.)

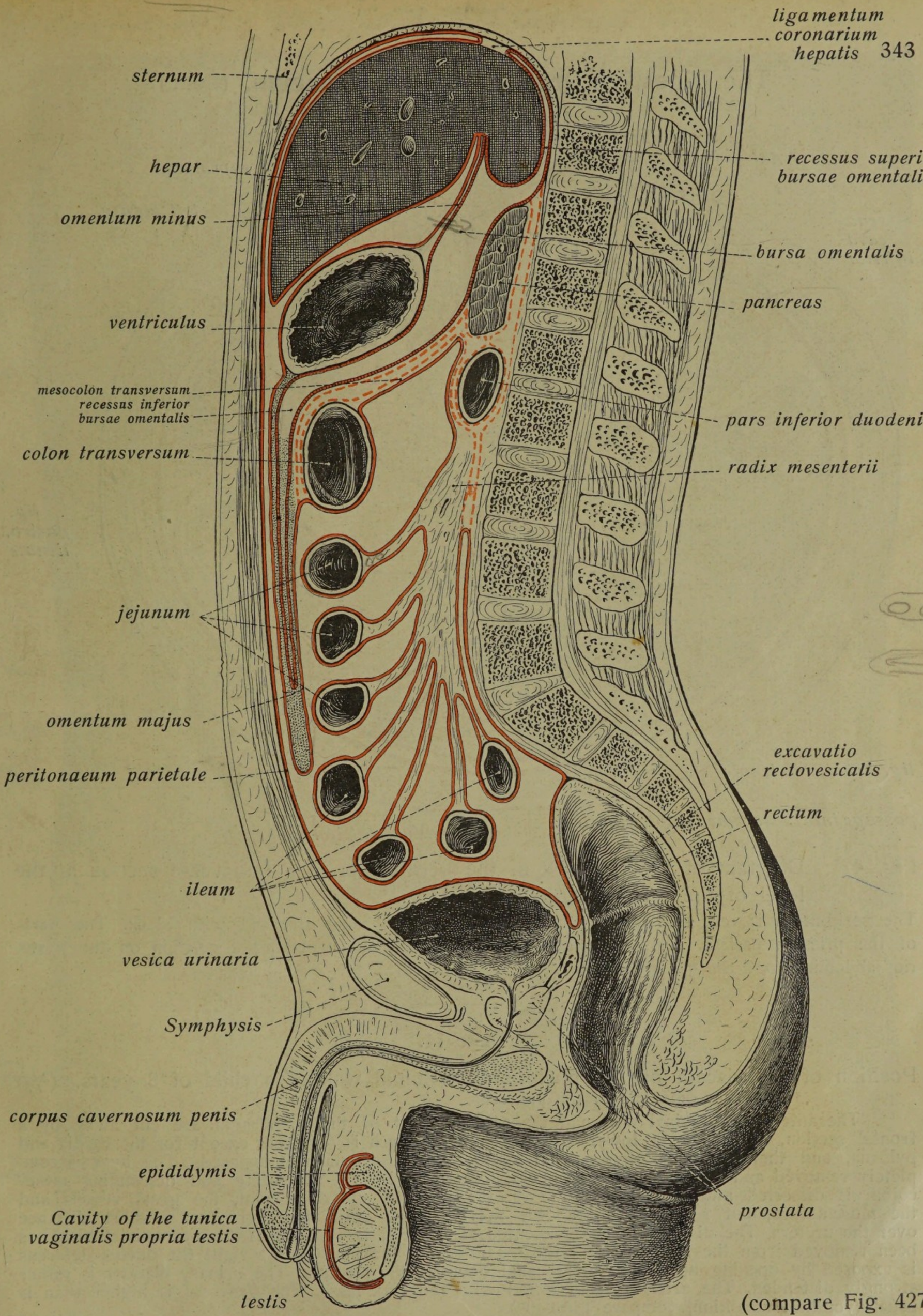
The Peritoneum. (Cont.)

Immediately below this line begins the *root of the mesentery,* which runs obliquely (from the left and above, downwards and to the right) across the lumbar portion of the vertebral column, supplying the peritoneal covering for all the mesenterial portion of the small intestine. Its line of origin passes at an acute angle into that of the transverse mesocolon. After forming the usually very broad *sigmoid mesocolon* the peritoneum descends into the true pelvis, where it covers the upper part of the anterior wall of the rectum. Thence it is reflected in the male upon the bladder, in the female upon the fornix of the vagina and the uterus (see Fig. 427). From the bladder it then passes with the *umbilical ligaments* (Fig. 425) back to the anterior abdominal wall to become parietal peritoneum. There is a *median umbilical ligament* (= obliterated urachus) and two *lateral umbilical ligaments* (= obliterated hypogastric arteries).

The peritoneal pouch which is thus formed in the male between the rectum and the bladder is the *recto-vesical pouch*, while in the female, owing to the interposition of the uterus between the bladder and rectum, there are two pouches, the *recto-uterine pouch* between the rectum and the uterus or posterior fornix of the vagina and the *vesico-uterine pouch* between the uterus and the bladder. The widths of the rectovesical and recto-uterine pouches vary according to the extent to which the bladder and rectum are filled and they may be occupied by moveable portions of the intestine (loops of the small intestine or sigmoid colon.)

By the umbilical ligaments and by the *epigastric folds* formed by the blood vessels of the same name, five shallow depressions are formed upon the anterior abdominal wall, the *supravesical fovea*, between the ligaments, and the paired *medial and lateral inguinal foveae*, separated by the epigastric folds.

The lateral inguinal fovea flattens out above and laterally, but its deepest point, where the epigastric fold crosses the inguinal (Poupart's ligament), marks the site of the *abdominal inguinal ring*. In the adult it is scarcely more than a slight depression.



(compare Fig. 427).

Fig. 420. Diagram of the relations of the peritoneum in a median section of a male
The peritoneum is red, that of the bursa omentalis being also streaked with black. The portions of the peritoneum that later disappear are shown by broken red lines and the portions of the peritoneal cavity that disappear are stippled with black.

The Digestive Organs. The Peritoneum. (Cont.)

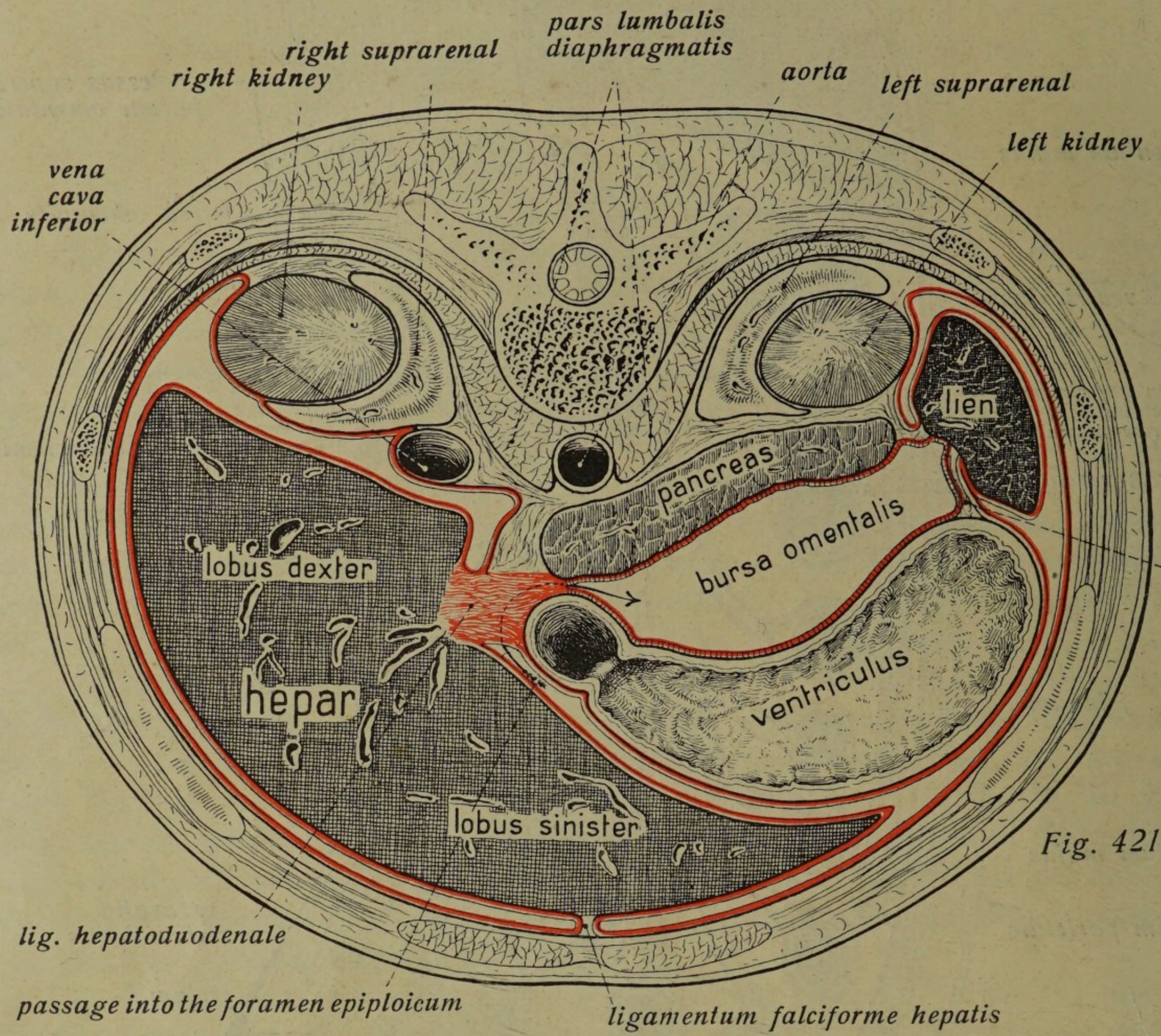


Fig. 421.

Fig. 421. Diagram of the relations of the peritoneum in a transverse section at the level of the bursa omentalis.

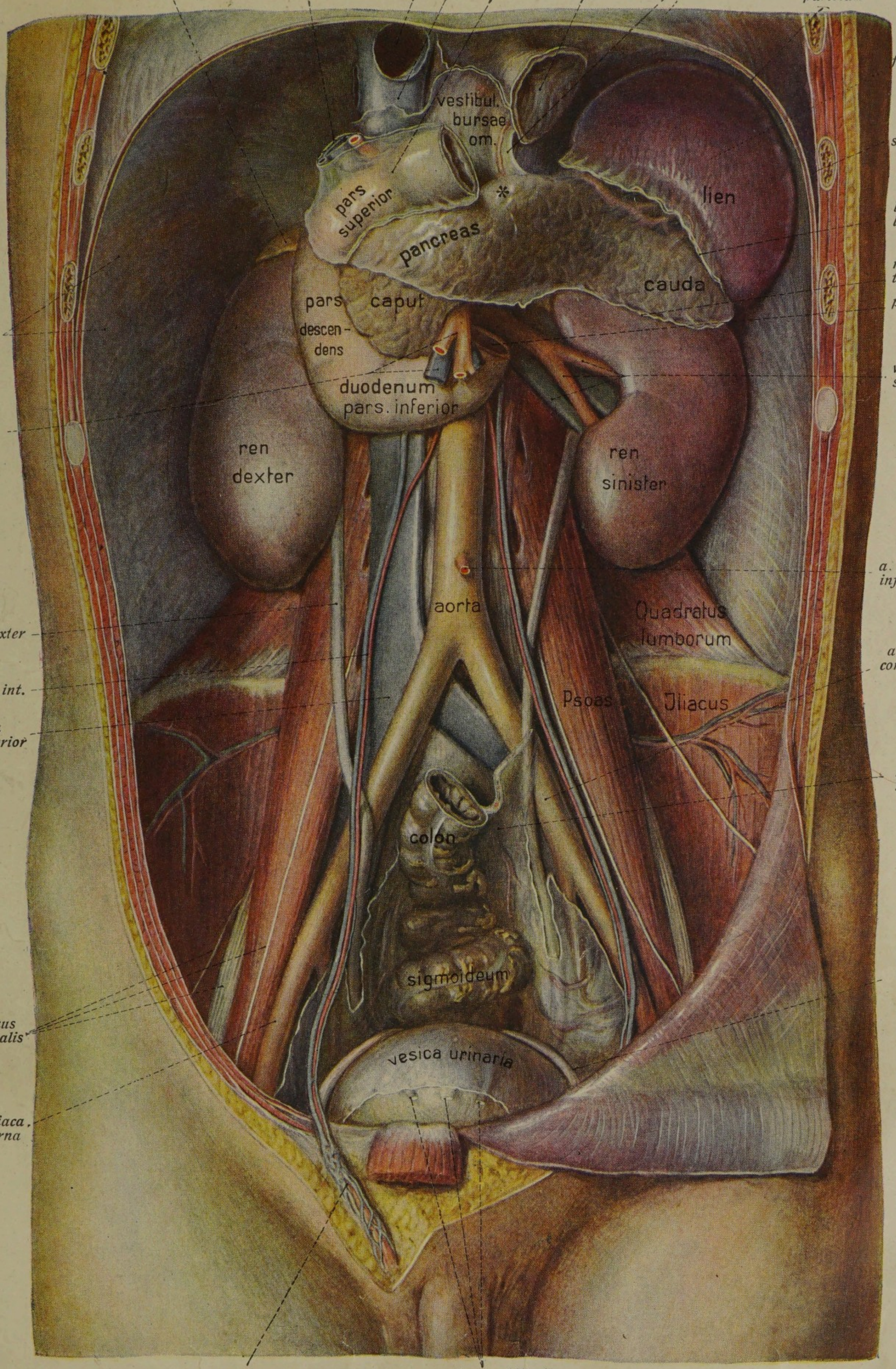
The peritoneum is red, that of the bursa omentalis being also streaked with black. The parts of the primary parietal peritoneum obliterated by the pancreas taking a position on the posterior abdominal wall are not represented.

Plate 11.

Position of the viscera on the posterior abdominal wall of a child of 8 years. ($^2/_3$)
* = tuber omentale of the pancreas.

The anterior abdominal wall and the anterior part of the diaphragm are cut away by a frontal section, except for a lower left flap. The stomach is removed, except for the cardia and pylorus, and thereby the posterior wall of the bursa omentalis is exposed. The liver is completely removed and the parietal peritoneum, together with the ascending and descending mesocolon, is dissected away from the kidneys, the most of the duodenum, the great vessels and the musculature, but retained in the true pelvis, being split, however, for a short distance over the ureters. The diaphragm is represented as covered by the fascia transversalis, which has been removed from the Iliopsoas and the Quadratus lumborum. On the right the ductus deferens is exposed by opening up the inguinal canal down to the scrotum. The urinary bladder is rather strongly distended. The arteries are injected with red wax mass. The pancreas is higher than is usual (youthful condition, compare Fig. 409).

Tab. II.


landula suprarenalis dextra
lig. hepato-duodenale
vena hepatica
vena cava inferior
pylorus
cardia
plica gastro-pancreatica
peritonaeum parietale
facies gastrica lienis
sinus phrenico-costalis
lig. gastro-lienale ×
mesocolon transvers. ×
pars ascendens duodeni
vasa renalia sinistra
a. mesenterica inferior
a. iliaca communis
mesocolon sigmoideum
ductus deferens
Diaphragma
vasa mesenterica superiora
ureter dexter
vasa spermatica int.
vena cava inferior
plexus lumbalis
a. iliaca externa
funiculus spermaticus
ligg. umbilicalia
vestibul. bursae om.
pars superior
pancreas
lien
cauda
pars descen-dens
caput
duodenum pars. inferior
ren dexter
ren sinister
aorta
Quadratus lumborum
Psoas
Iliacus
colon
sigmoideum
vesica urinaria

The Digestive Organs. The Peritoneum. (Cont.)

Plate 12.

The so-called retroperitoneal organs of a very thin female body. (1/2) The anterior abdominal wall is largely removed. Of the abdominal viscera the following have been removed: the stomach, the spleen, the large intestine, the small intestine up to the duodenum and the liver, except for a small portion in relation to the inferior vena cava. The mesentery has been removed with the intestine so that the lines of its origin from the parietal peritoneum are shown. The latter is left undisturbed, as are also the contents of the true pelvis. The so-called retro-peritoneal organs (pancreas, duodenum, kidneys and suprarenal glands) as well as the organs of the true pelvis are seen through the parietal peritoneum. * = the so-called splenic pouch of the peritoneal cavity.

Fig. 423. The vestibule of the bursa omentalis. (2/5) The flaccid portion of the lesser omentum is cut to give a view of the vestibule with the caudate lobe of the liver and the tuber omentalis of the pancreas. A sound is passed through the epiploic foramen.

Fig. 424. The bursa omentalis. (2/5) Preparation similar to that of Fig. 423, except that the lesser curvature of the stomach is drawn downwards and to the left, to show the isthmus of the bursa omentalis with the gastro-pancreatic fold.

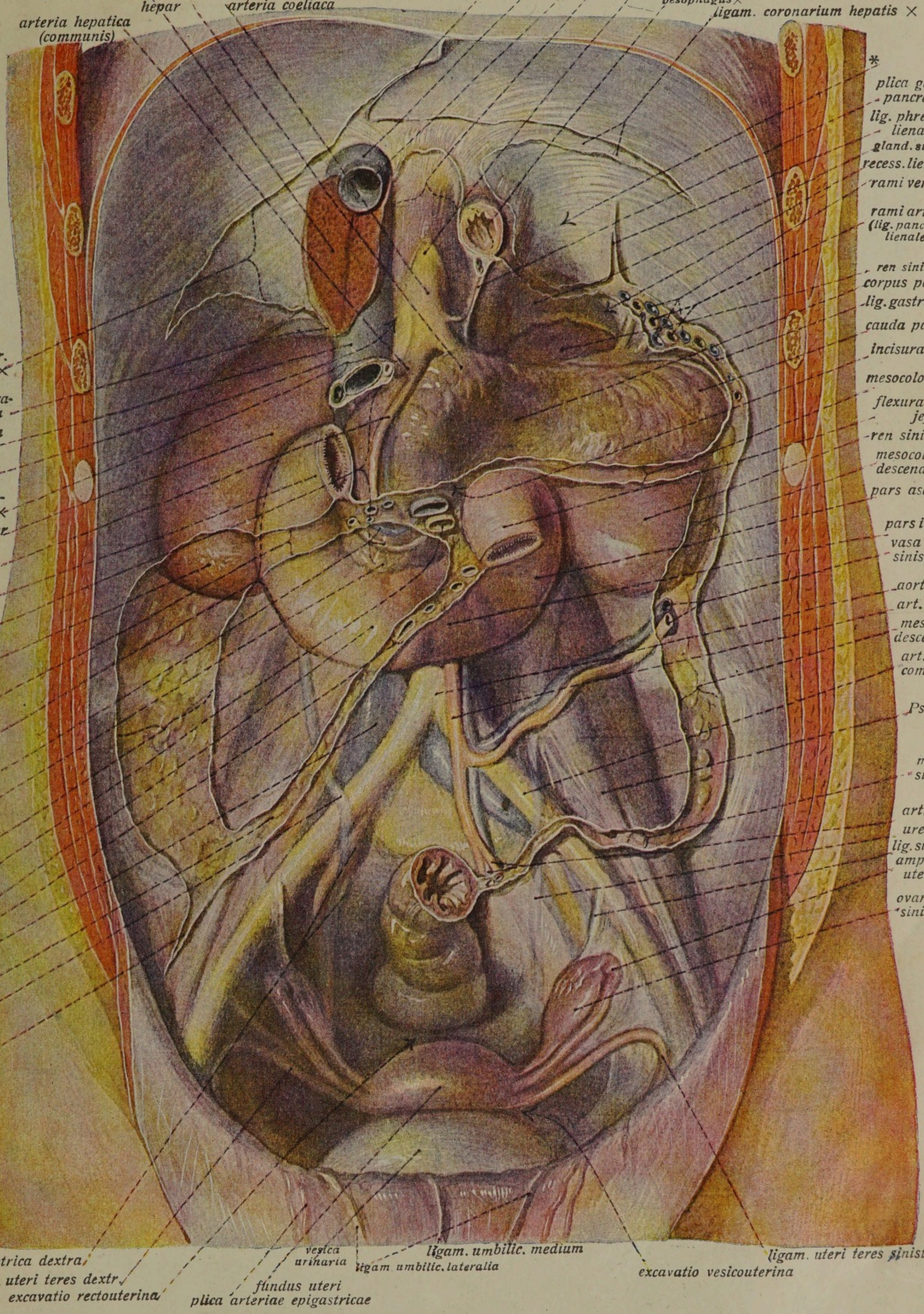
The Péritoneum. (Cont.)

The *bursa omentalis* is a peritoneal recess situated, in general, between the posterior surface of the stomach and the anterior surface of the pancreas, and usually communicating with the general peritoneal cavity by the *epiploic foramen* (foramen of Winslow) at the right edge of the hepato-duodenal ligament. Its peritoneal wall covers the posterior surface of the stomach, the anterior surface of the body and tail of the pancreas and the caudate lobe of the liver. To the left the bursa omentalis extends as far as the spleen and its ligaments (Fig. 422); the narrow portion into which the epiploic foramen opens and which corresponds in extent to the caudate lobe of the liver is termed the *vestibule*.

In addition the bursa extends, as the so-called *inferior recess,* into the great omentum, which, especially in its early stages of development, is a hollow sac. Its walls, however, are firmly in opposition, since they are separated only by the absolutely cleft-like cavity of the peritoneum.

The two splenic ligaments, the *gastro-lienal (gastro-splenic)* and *pancreatico-lienal (pancreatico-splenic)* are duplicatures of the peritoneum, one layer of which is formed by the peritoneum of the general peritoneal cavity and the other by that of the bursa omentalis (compare Fig. 422).

Tab. 12.


vena cava inferior
vena hepatica
ligam. falci-forme hepatis
vestibulum bursae omentalis
hiatus aorticus
oesophagus ×
ligam. coronarium hepatis ×
tuber omentale pancreatis
hepar
arteria coeliaca
arteria hepatica (communis)
*
plica gastro-pancreatica
lig. phrenico-lienale ×
gland. supraren. sin.
recess. lien. burs. om.
rami venae } lienalis ×
rami arter. }
(lig. pancreatico-lienale ×)
ren sinister
corpus pancreat.
lig. gastrolienal. ×
cauda pancreat.
incisura pancreat.
mesocolon transv.
flexura duodeno-jejunalis
ren sinister
mesocolon descend. ×
pars ascend. } duodeni
pars infer. }
vasa colica sinistra ×
aorta abdom.
art. mesent. inf.
mesocolon descendens ×
art. iliaca comm. sin.
Psoas
mesocolon sigmoideum
art. sigmoid.
ureter sin.
lig. suspens. ovar.
ampulla tubae uterinae
ovarium sinistrum
ligam coronar. hepat. dextr. ×
glandula supra-renalis dextra
vena cava inferior
foramen epip'oicum
lig. hepato-duodenale ×
ren dexter
art. gastro-duodenalis
pars superior duodeni ×
caput pancreatis
extr. inf. ren. dextr.
mesocolon transvers. ×
rs descen-s duodeni
sa colica media
roc. uncin. ancreatis
esocolon cendens ×
rt. mesen-erica sup.
rs inf. duod.
x mesent. ×
na cava inf.
radix esenterii ×
ureter dexter
meso-coecum ×
vasa hypogastrica dextra
ligam. uteri teres dextr.
excavatio rectouterina
vesica urinaria
plica arteriae epigastricae
fundus uteri
ligam. umbilic. medium
ligam. umbilic. lateralia
excavatio vesicouterina
ligam. uteri teres sinistr.

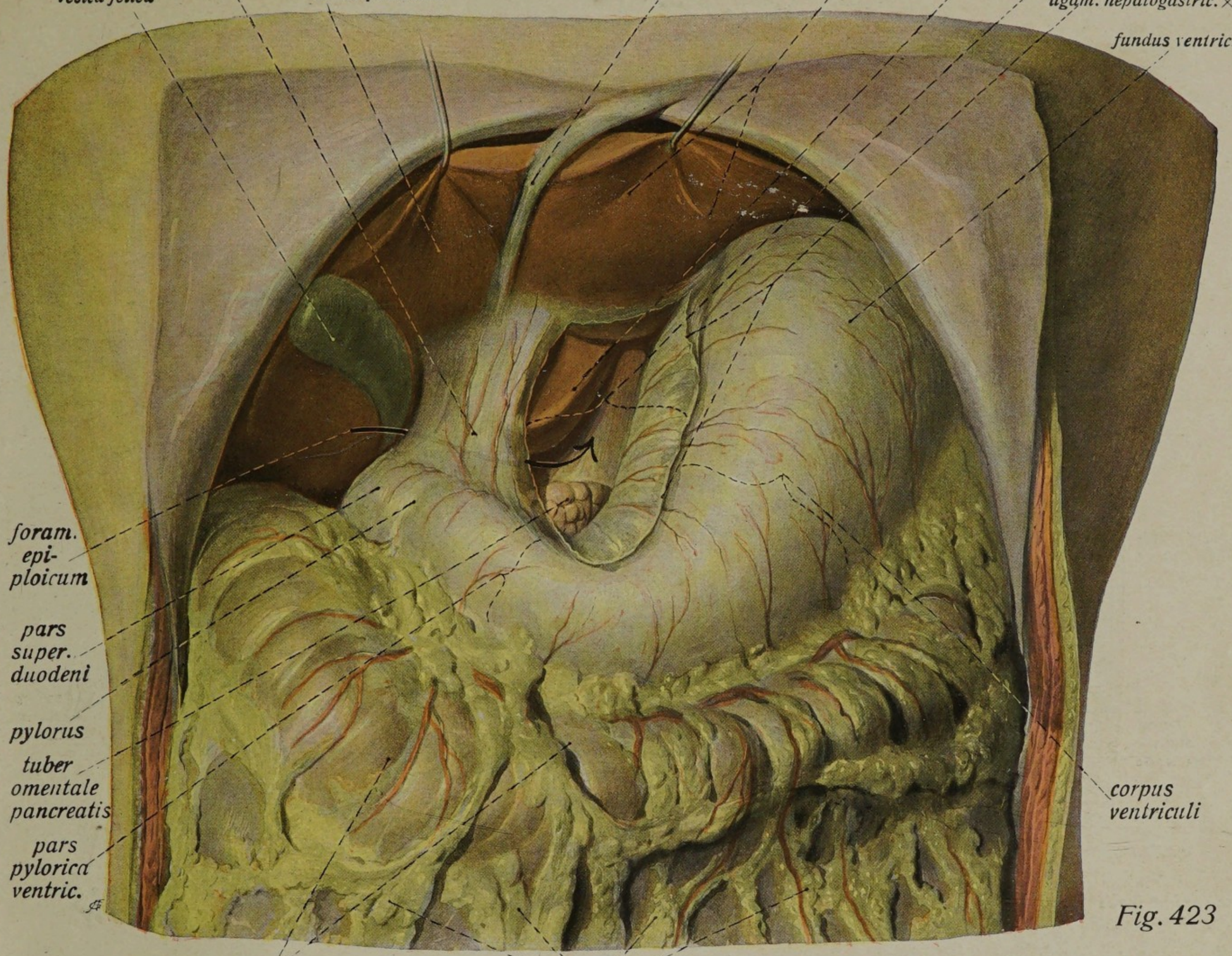


Fig. 423

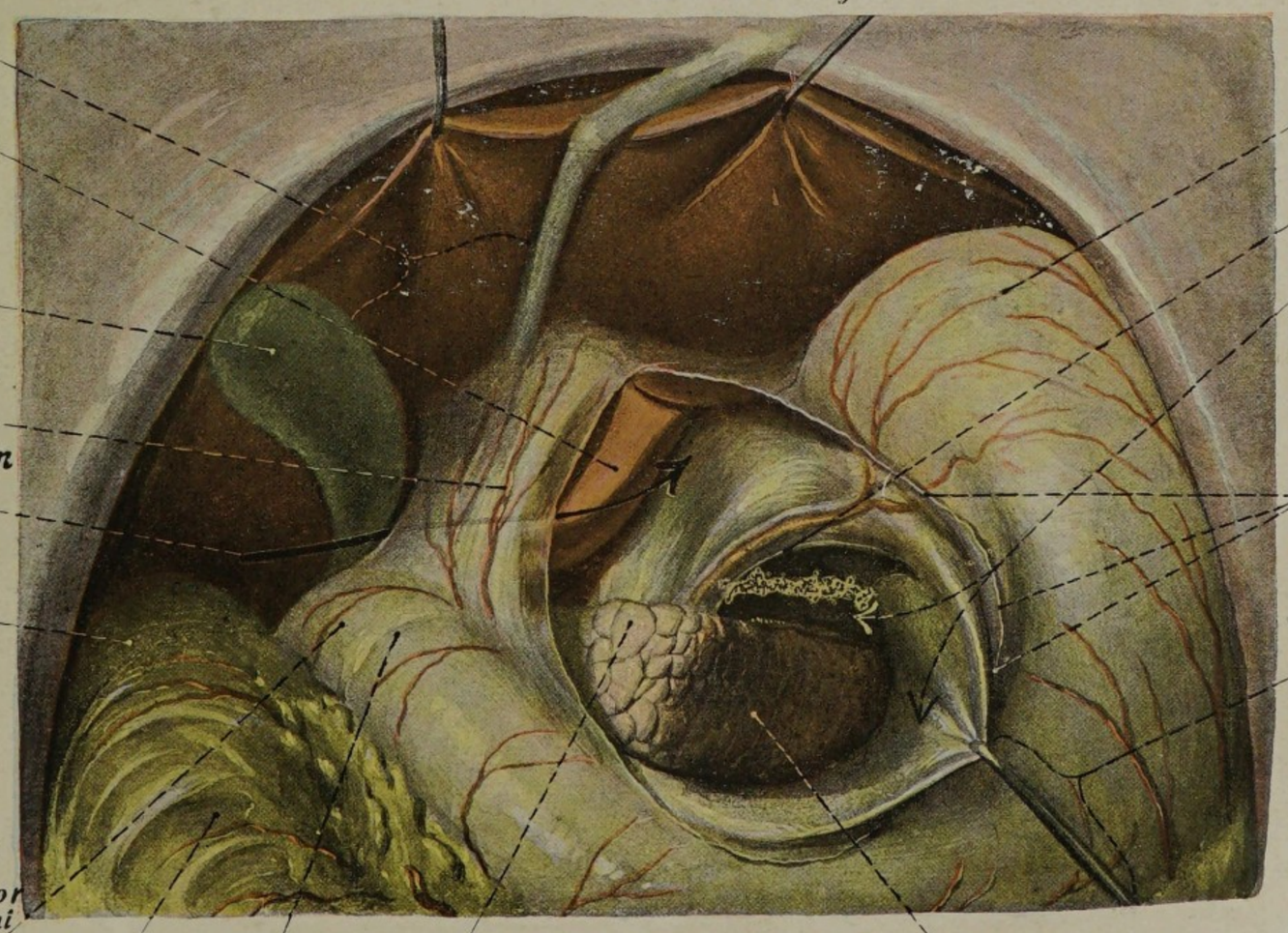


Fig. 424

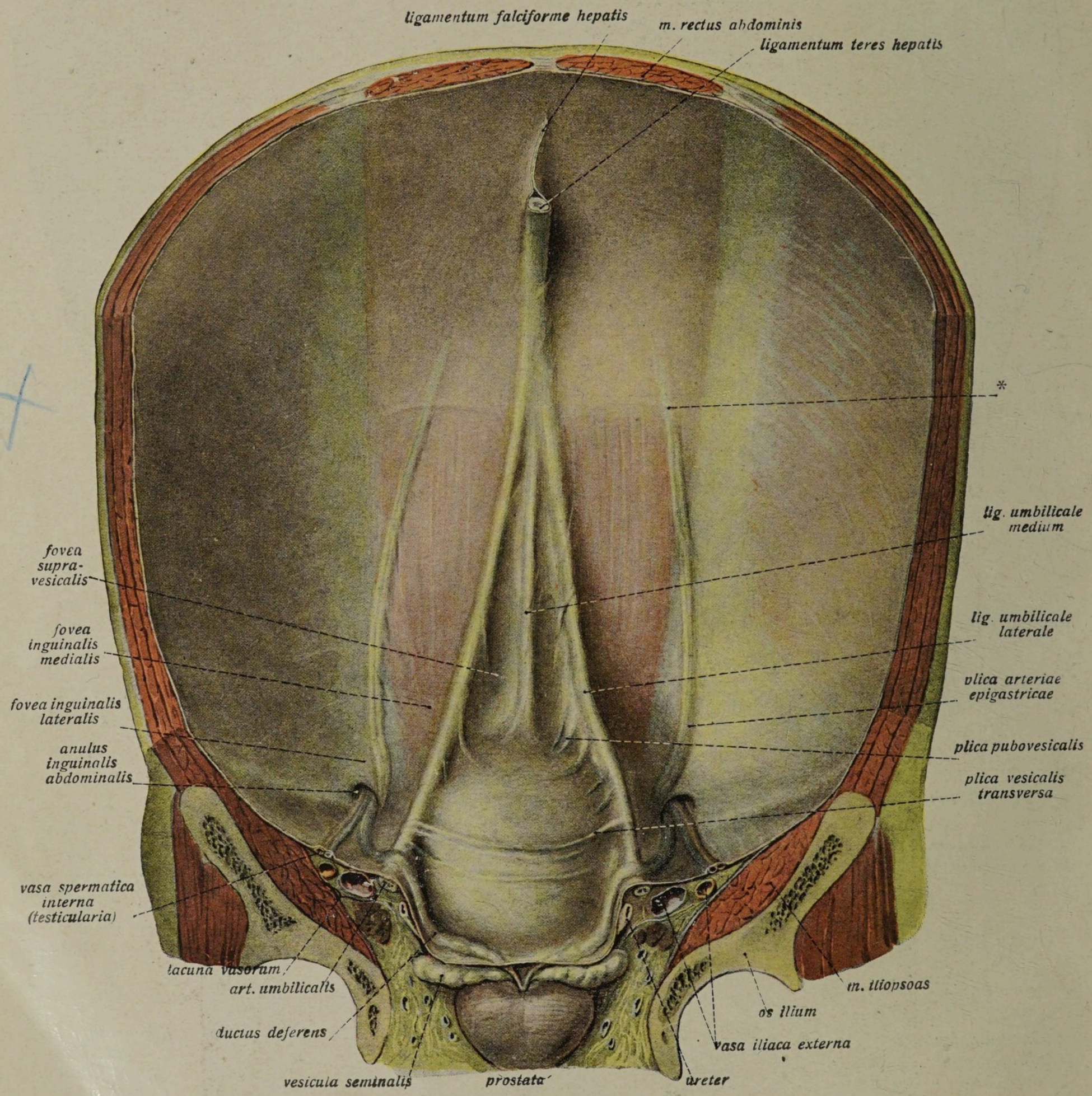

ligamentum falciforme hepatis
m. rectus abdominis
ligamentum teres hepatis
*
lig. umbilicale medium
fovea supra-vesicalis
lig. umbilicale laterale
fovea inguinalis medialis
plica arteriae epigastricae
fovea inguinalis lateralis
plica pubovesicalis
anulus inguinalis abdominalis
plica vesicalis transversa
vasa spermatica interna (testicularia)
lacuna vasorum
art. umbilicalis
m. iliopsoas
os ilium
ductus deferens
vasa iliaca externa
vesicula seminalis
prostata
ureter

Fig. 425

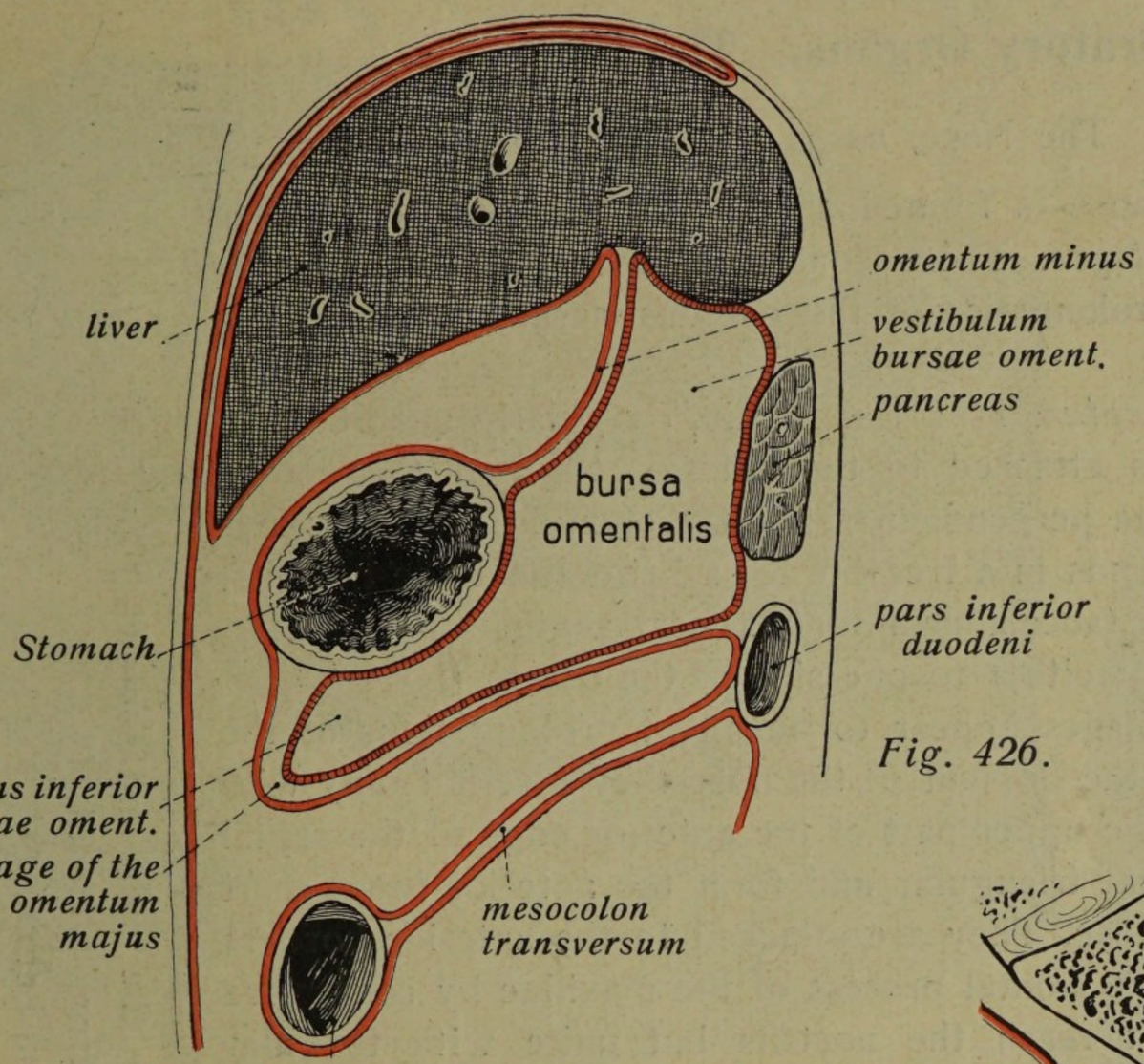


Fig. 426.

Fig. 425. The anterior abdominal wall and the bladder of a new-born child, from behind. The anterior abdominal wall has been separated by a frontal section through the region of the hip joints and by a horizontal section above the umbilicus. * = position of the semicircular line of Douglas.

Fig. 426. Diagram of the formation of the great omentum in the embryo.
A median section. The peritoneum is red, that of the bursa omentalis also streaked with black. The transverse mesocolon has not yet fused with the great omentum (compare Fig. 420).

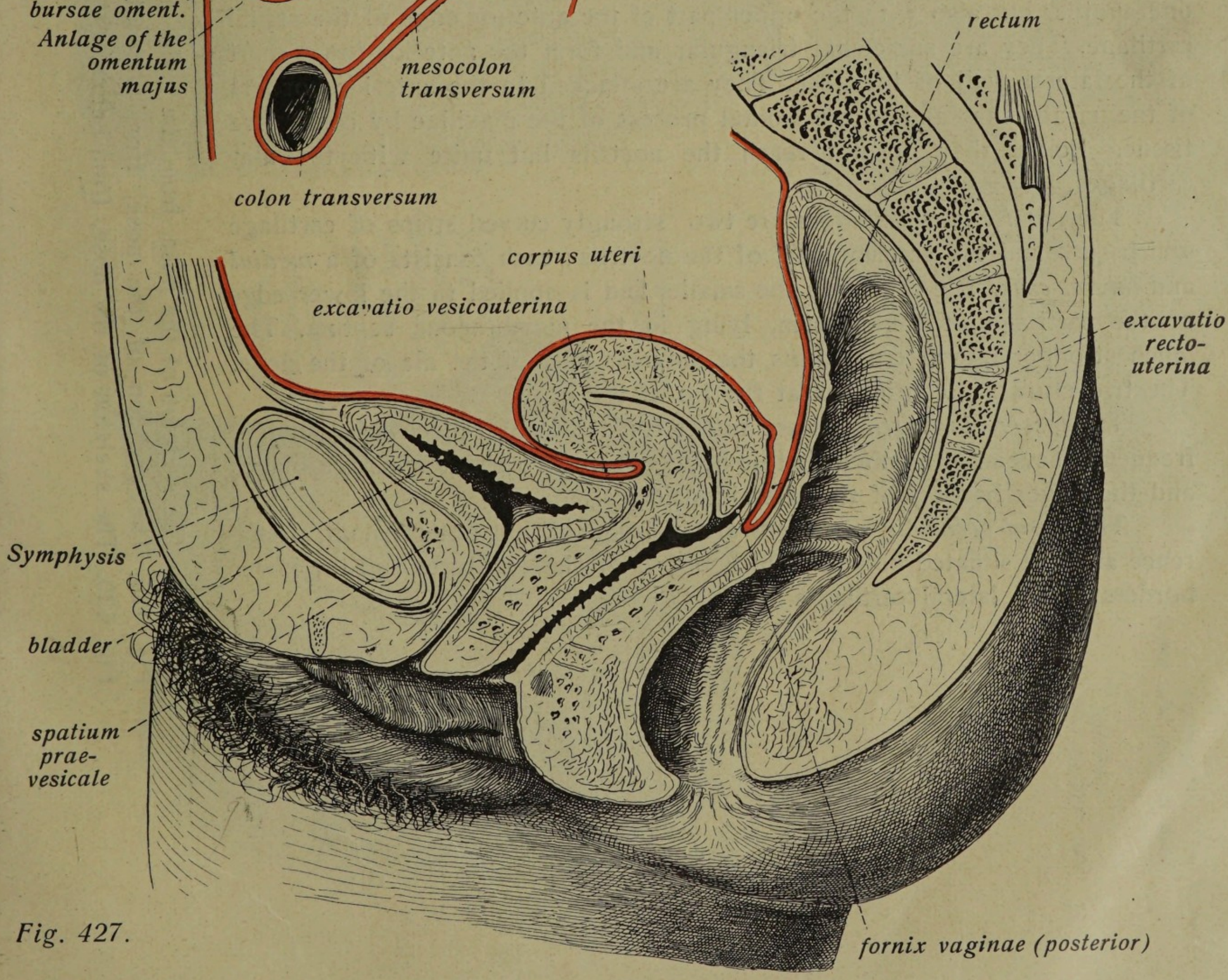


Fig. 427.

Fig. 427. The arrangement of the peritoneum in the female pelvis.
A median section. Peritoneum red.

The Respiratory Organs. The Nose.

The Nose, *nasus*.

The skeleton of the nose is formed only partly of bone, the rest is formed by the *nasal cartilages*. These consist of an unpaired cartilage, which forms the anterior prolongation of the osseous nasal septum, and a number of paired cartilages.

The *cartilage of the septum* is a rather thin, irregularly quadrangular plate of cartilage, which is attached to the anterior edge of the vomer, the lower edge of the lamina perpendicularis of the ethmoid and the upper edge of the nasal crest. It ends in a free border a little above the nostrils, so that there is for a short distance a membranous nasal septum. The cartilaginous septum is usually bent either to one side or the other.

The lateral nasal cartilages appear to be direct prolongations of the septal cartilage, in that on the dorsum of the nose they fuse not only with one another but also with the upper part of the anterior edge of the septal cartilage. They are somewhat triangular and form the anterior lower part of the lateral wall of the nose. They are attached to the anterior borders of the nasal bones and to the frontal process of the maxillae by connective tissue. Below they do not reach the nostrils but unite with the alar cartilages.

The *greater alar cartilages* are two strongly curved strips of cartilage which surround the anterior part of the nostrils; each consists of a *medial* and *lateral crus*. The former is the smaller and is applied to the lower edge of the cartilage of the septum, lying in the membranous septum. The much stronger lateral crus forms the anterior part of the ala of the nose. The two crura are continuous at the tip of the nose.

The *lesser alar cartilages* are rather constant, small pieces of cartilage, frequently several in number, that lie between the two greater alar cartilages and the lower borders of the lateral cartilages.

The *nasal sesamoid cartilages* are of frequent, but not constant, occurrence and are situated between the two greater alar cartilages and the lower borders of the lateral cartilages.

Fig. 428. The skeleton of the nose, from the right and somewhat in front. ($^9/_{10}$)
Fig. 429. The skeleton of the nose, from in front. ($^9/_{10}$)
Fig. 430. The skeleton of the nose, from below. ($^9/_{10}$)

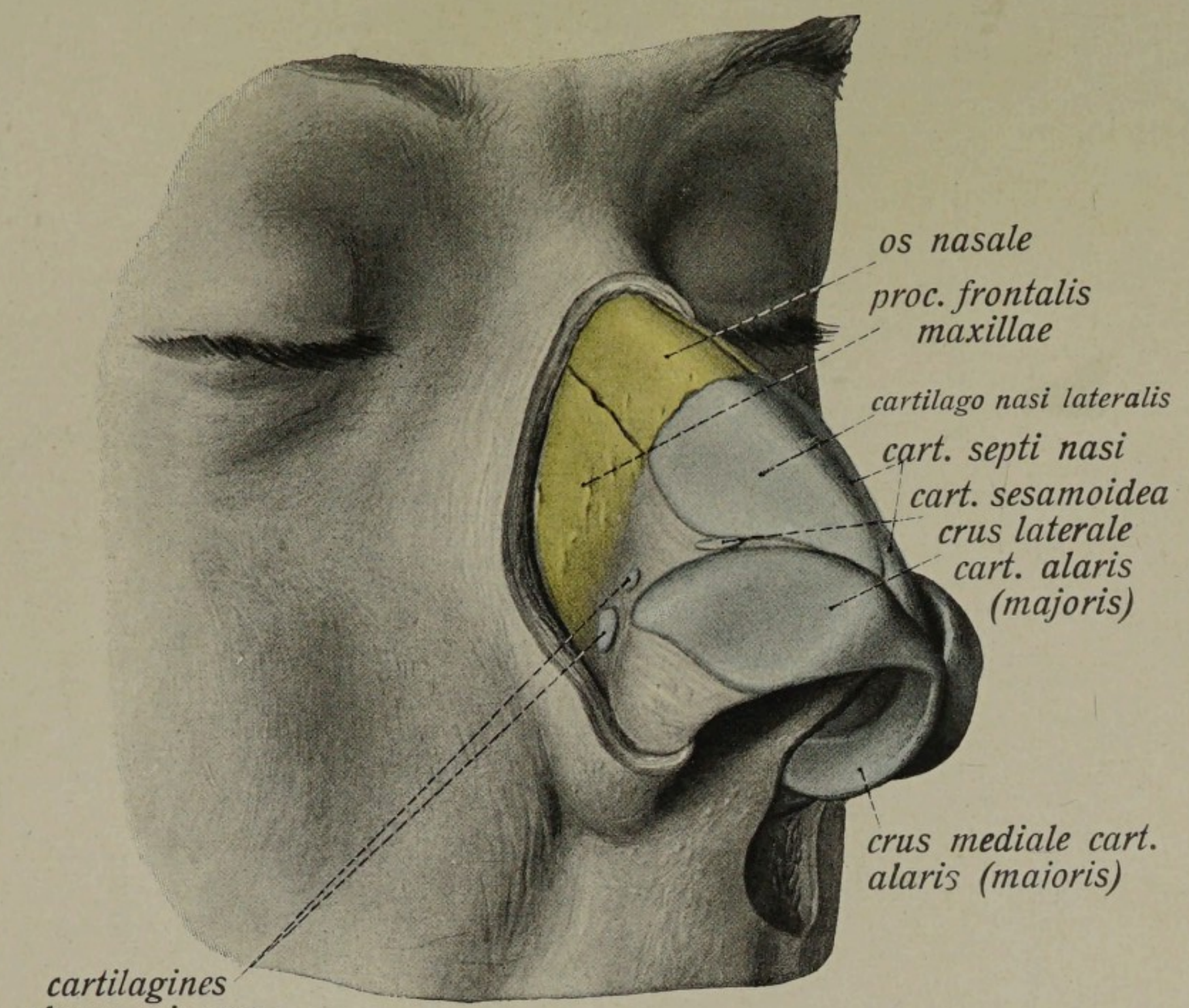


Fig. 428

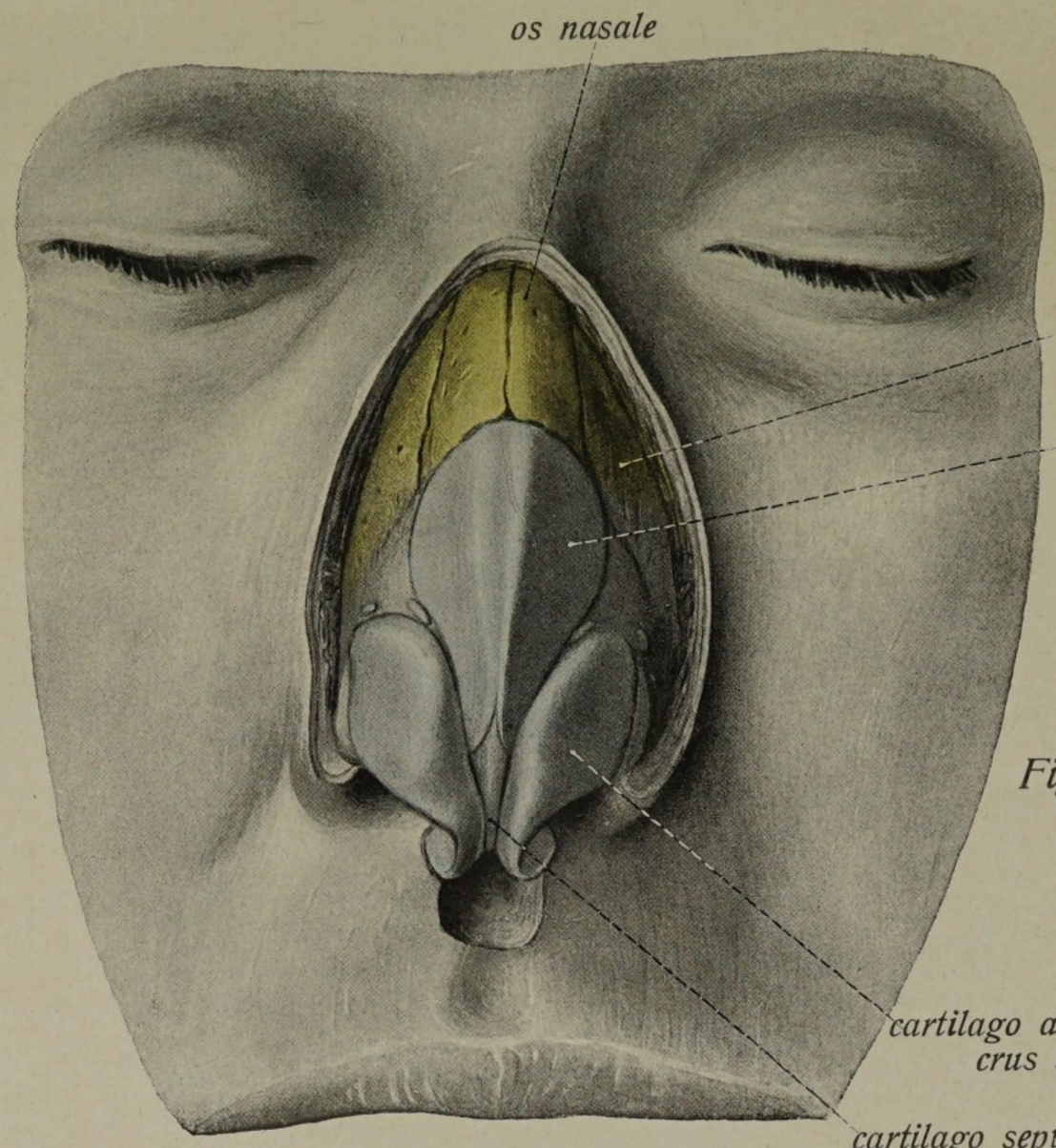


Fig. 429.

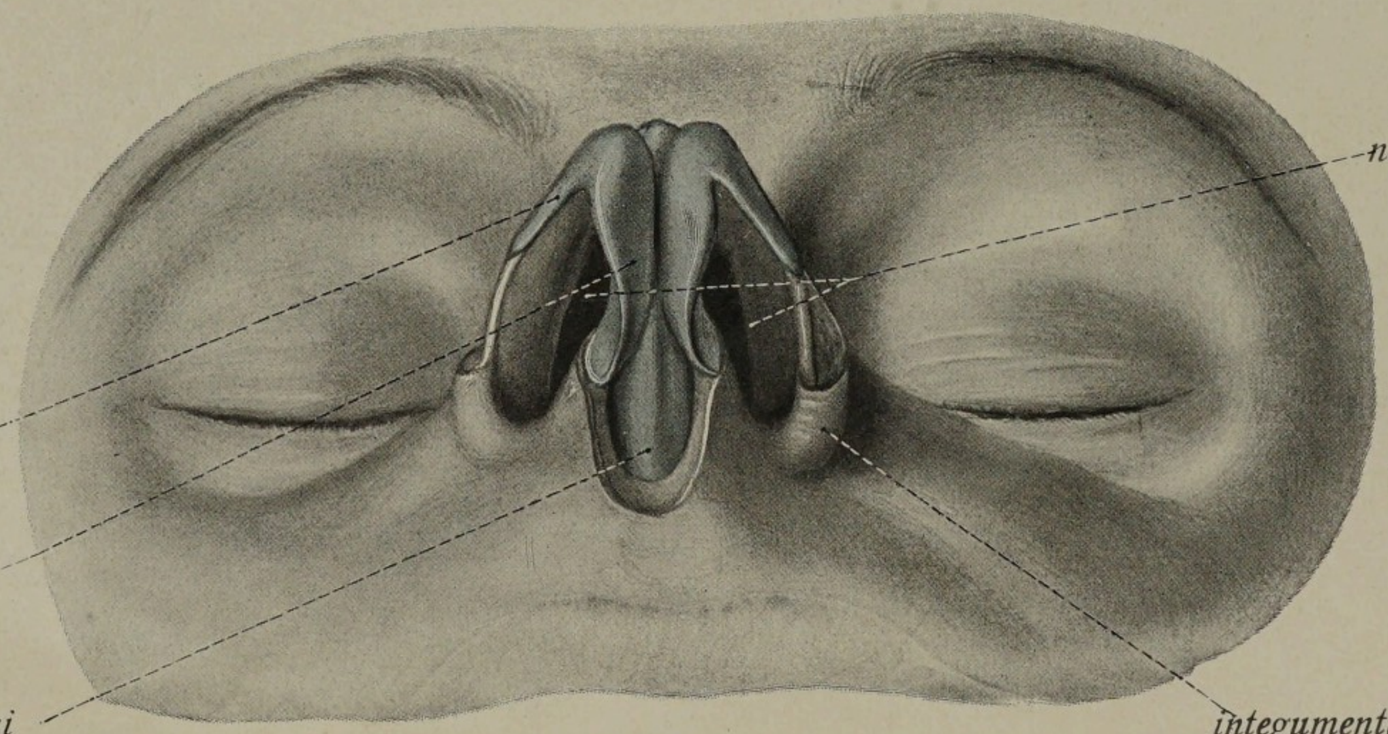


Fig. 430.

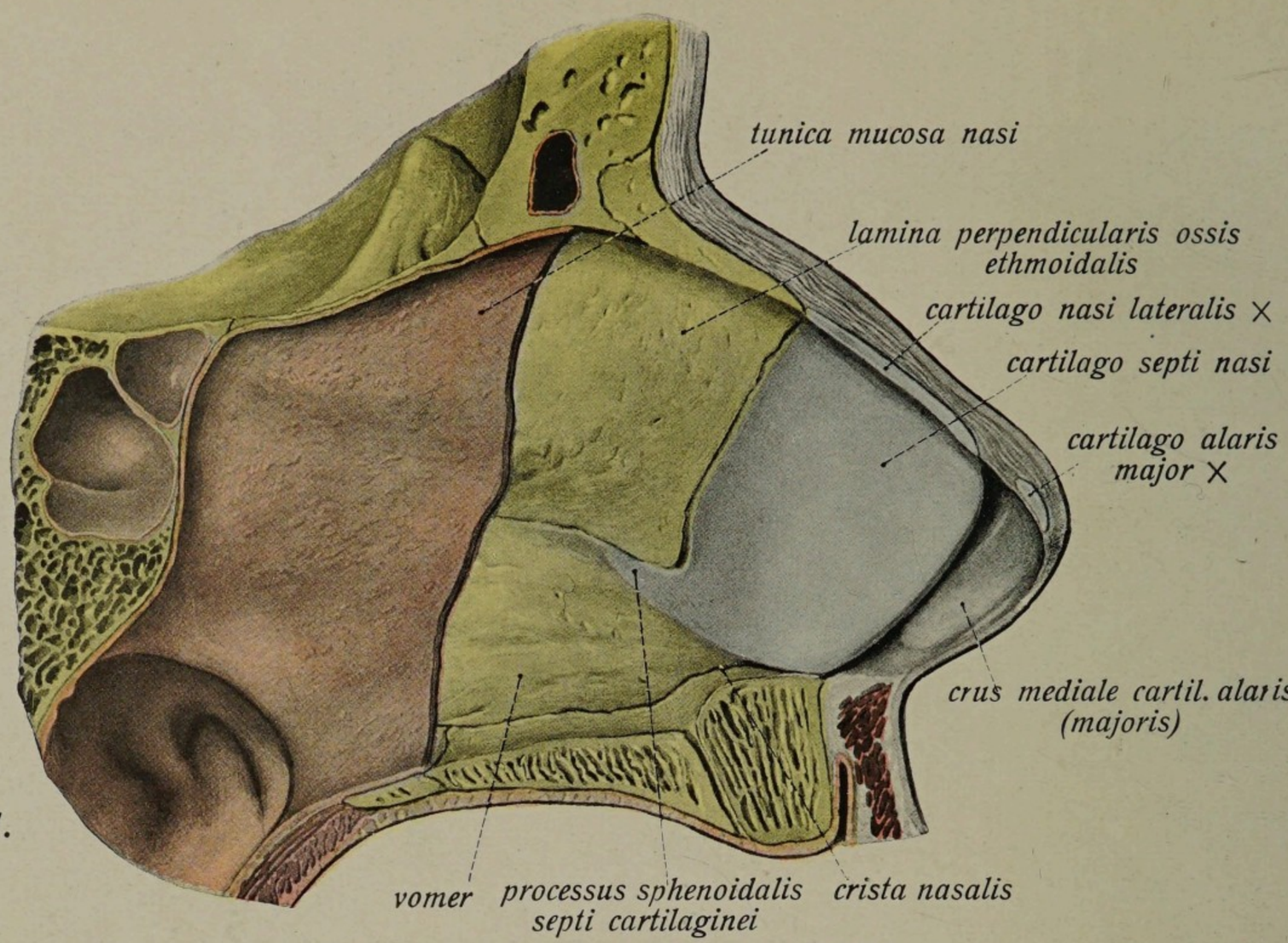


Fig. 431.

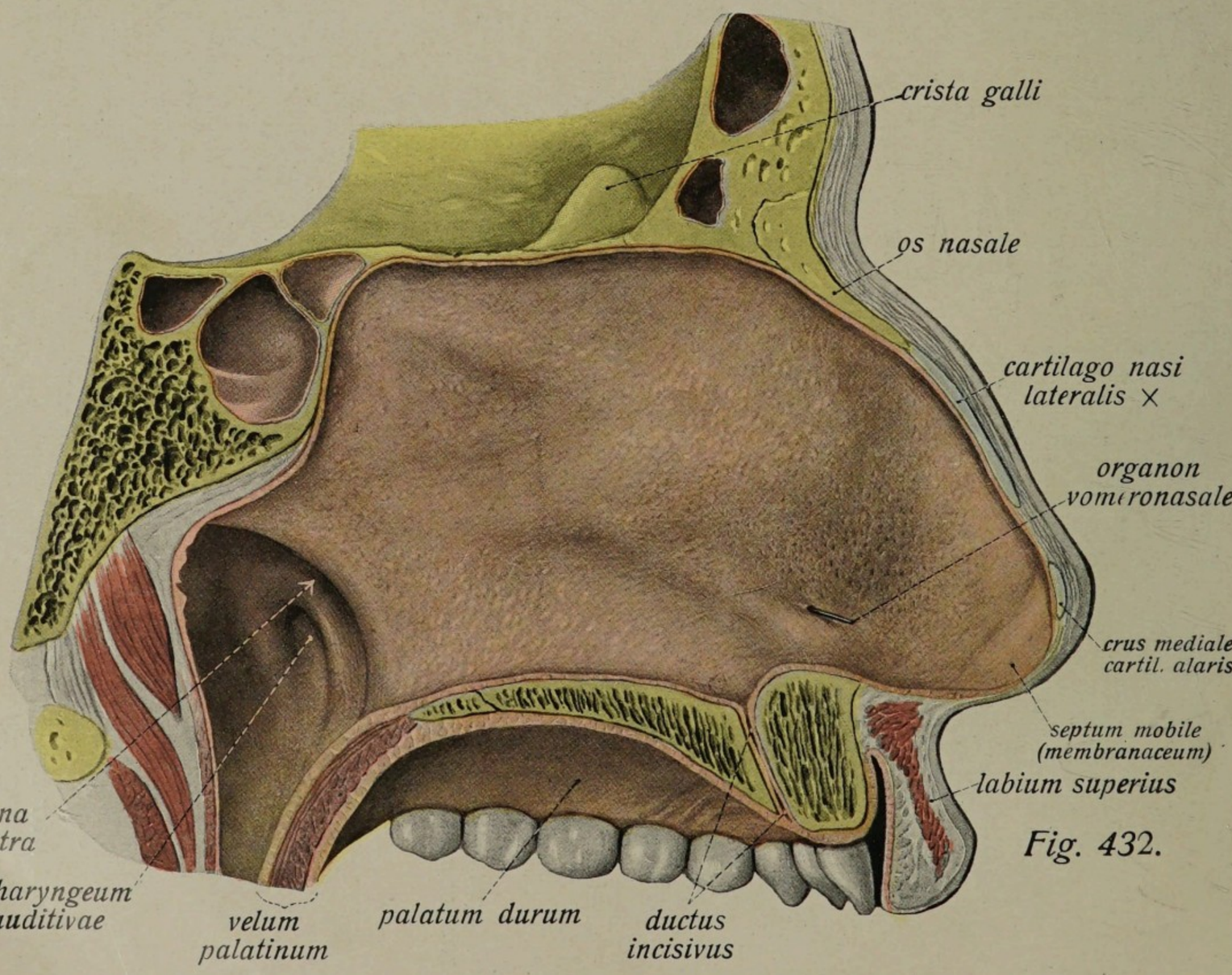


Fig. 432.

The Respiratory Organs. The Nasal Cavity.

Fig. 431. The nasal septum, from the right side. Over its anterior half the mucous membrane is removed. ($^9/_{10}$)

Fig. 432. The medial wall of the nasal cavity (nasal septum) with its mucous membrane, from the right side. ($^9/_{10}$) A sound is in the blind pouch-like rudiment of Jacobson's organ.

The Nasal Cavity.

The cavity of the nose repeats, with but slight differences, the arrangement of the osseous nasal cavity. Only the anterior, lower portion has cartilaginous or membranous walls. It is divided by the *septum* into two symmetrical halves, each of which has an anterior opening at the nostrils (*nares*) and a posterior one, the *choana,* which leads into the pharynx. In each cavity there are recognized a *vestibule* and the cavity proper. The vestibule forms the transition between the external skin and the mucous membrane of the nose, and is separated from the cavity proper by a ridge, the *limen nasi.* Near the nares there are strong hairs, *vibrissae,* in the skin of the vestibule, and in addition sebaceous glands.

The boundaries of the actual nasal cavities are essentially the same as those of the bony cavity.

Thus there are three *conchae*, *superior*, *middle* and *inferior*, covered with mucous membrane and containing the bony structures of the same names, but appearing more rounded than the bony ones on account of the mucous covering. Springing from the lateral wall of the cavity they divide the lateral part of the cavity into the three *meatus, superior*, *middle* and *inferior*, the remaining part of the cavity, between the free borders of the conchae and the septum, being termed the *common meatus*. The inferior meatus is between the inferior concha and the nasal surface of the palate, the superior between the middle and superior conchae.

The *agger nasi*, a slight elevation extending from the anterior end of the middle concha towards the tip of the nose, separates off, with the help of the anterior end of the inferior concha, the antrum of the middle meatus; this lies anterior to the middle meatus.

The Respiratory Organs. The Nasal Cavity (Cont.) and its Accessory Sinuses.

Fig. 433. The lateral wall of the nasal cavity, from the left. ($^9/_{10}$)
Fig. 434. The lateral wall of the nasal cavity from the left. The inferior and middle conchae are cut away near their bases. ($^9/_{10}$)

Above the superior concha, between it and the roof of the nasal cavity, there is a blindly ending recess, the *spheno-ethmoidal* recess, which does not extend back to the choanae but ends on the anterior surface of the body of the sphenoid bone. Sometimes a short uppermost concha occurs here, the *concha suprema*.

Since the two upper conchae are by no means as long as the nasal cavity, there is a common space in front of their front ends and behind their hinder ends; the anterior space is termed the *carina* and the posterior the *naso-pharyngeal meatus*. The latter lies immediately in front of the lateral border of the choana and is a shallow groove.

Of the openings of the osseous nasal cavity there is a number that serve the passage of nerves and vessels and are closed by the mucous membrane of the nasal cavity, the spheno-palatine foramen for example. On the other hand there are others, such as the openings of the accessory cavities of the nose, that are evident in the cavity covered with mucous membrane. (Concerning these and the accessory cavities themselves see p. 357.) In addition, however, the following openings into the nasal cavity may be seen: In the inferior meatus, 2—3 cm from the nares and about 1 cm above the floor of the cavity, there is the inferior opening of the *naso-lacrimal duct*, which appears as a small slit partly covered by a small fold, the *plica lacrimalis*. Also in the floor of the cavity, beside the anterior end of the nasal crest, there is on either side an evagination of the mucous membrane into the incisive canal, the remains of a usually largely obliterated *incisive duct*.

Behind the opening of the incisive duct and above it there is frequently in the mucous membrane of the septum of young individuals a slender, horizontal mucous canal, the rudiment of Jacobson's organ *(vomero-nasal organ)*. It is usually well developed in the new-born child and is supplied by the olfactory nerve; in embryonic life it is fully established, although it later becomes quite rudimentary.

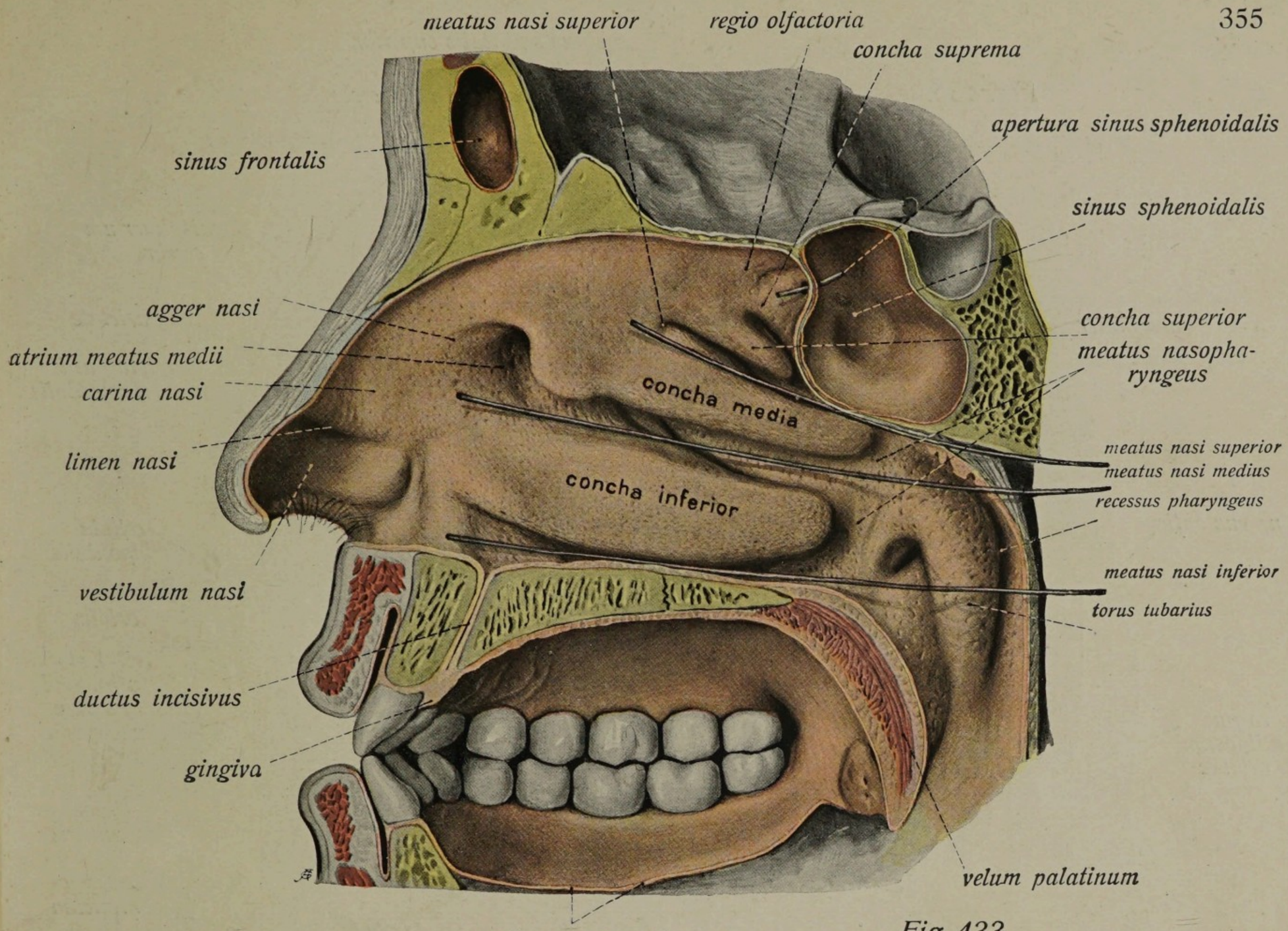


Fig. 433.

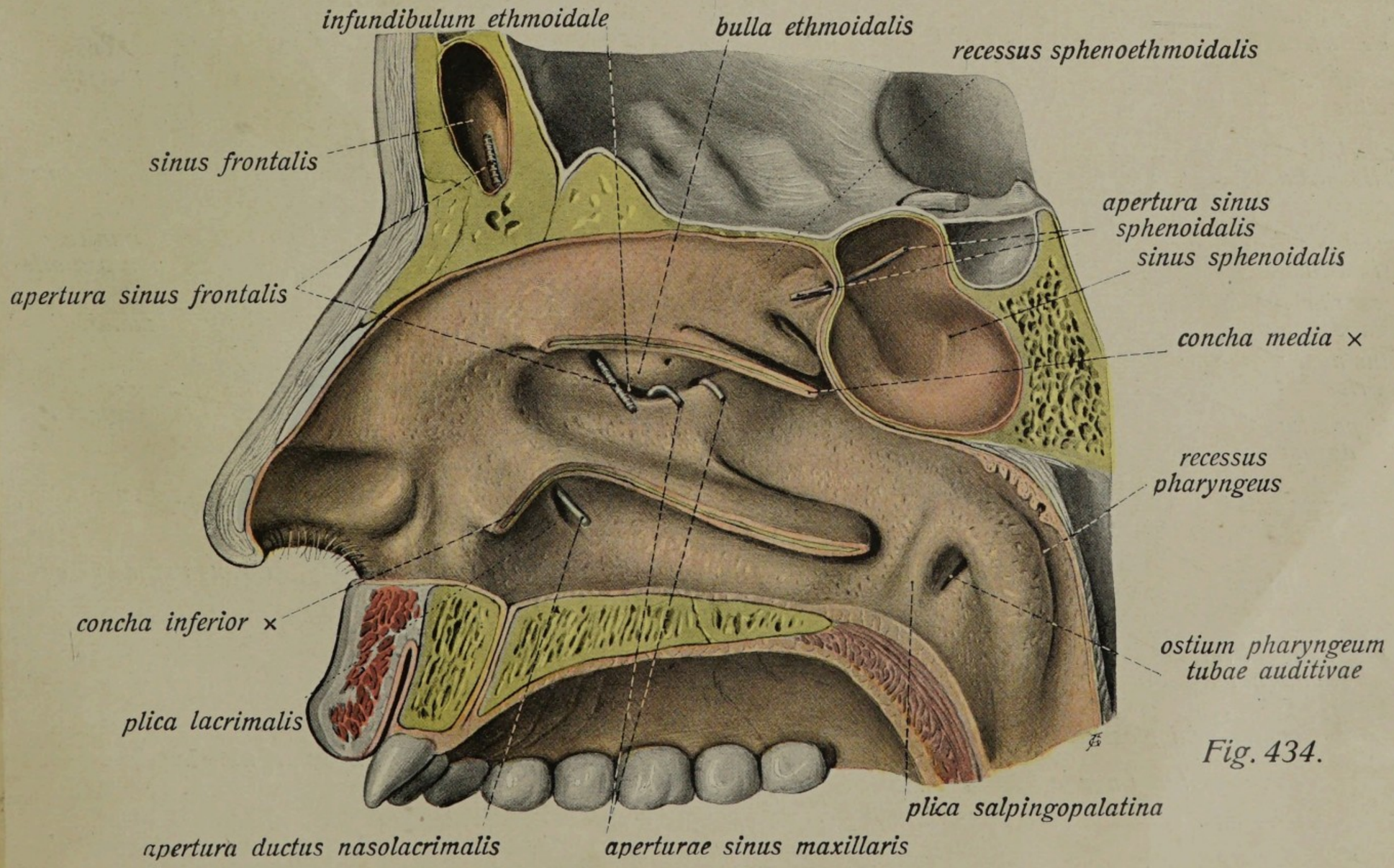


Fig. 434.

Fig. 435.

sinus sagittalis superior
falx cerebri
hemisphaerium cerebri
os parietale
crista galli ossis ethmoidalis
dura mater
nervus opticus
cellula ethmoidalis
orbita
cellul. ethm.
sept. nasi osseum
musculus temporalis
corpus adiposum orbitae
sinus maxillaris
os zygomaticum
musculi recti oculi (lat. med. infer.)
facies infer. orbitae
dens molaris
concha nasalis media
m. masseter
meatus nasi medius
tunica mucosa oris
concha nasalis infer.
dens molaris
meatus nasi inferior
musc. buccinator
palatum durum
platysma
cavum oris
corpus mandibulae
lingua
glandula salivaris sublingualis
musc. genioglossus
musc. digastricus venter anterior
septum linguae
musc. geniohyoideus
musc. mylohyoideus

The Nasal Cavity. (Cont.) The Accessory Nasal Sinuses.

Fig. 435. Frontal section through the head of a young man who had been executed. The section passes behind the eye-balls. ($^1/_1$) Accessory nasal sinuses, maxillary sinus, ethmoidal cells.

The section cuts the cranial cavity above, below that the two orbits (behind the eyeballs) and between them the ethmoidal cells, with the upper part of the nasal cavity; below these the maxillary sinuses are cut and between these the lower part of the nasal cavity with the middle and inferior meatus. Beneath is the mouth cavity.

The Accessory Nasal Sinuses, *sinus paranasales.*

These have in general the same relations as the corresponding bony cavities. They are lined by a thin mucous membrane, poor in glands and united to the periosteum of the cavities, together with which it may be readily removed from the bone. They may be divided into the smaller and multiple *ethmoidal cells* and the larger single cavities, such as the *frontal sinus*, the *sphenoidal sinus* and the *maxillary sinus*. Like the principal cavity, these accessory cavities are paired.

The *ethmoidal cells* are divided by a frontal partition into an anterior and a posterior group. The larger and less numerous (2—3) anterior cells open into the middle meatus, being separated from the infundibulum (see below) by the ethmoidal bulla, a convex prominence of the lateral nasal wall. The cells of the posterior group, smaller and more numerous (3—4) than those of the anterior group, open into the superior meatus.

The *frontal sinus* lies in the nasal portion of the frontal bone, but when they become enlarged they extend into the frontal plate and even into the orbital portion. Towards the nasal cavity the sinus narrows so as to become duct-like and opens into the middle meatus, in reality into the upper anterior portion of the so-called infundibulum, a groove-like depression of the lateral nasal wall below the ethmoidal bulla (see above).

The *sphenoidal sinus* lies in the anterior portion of the body of the sphenoid bone; the two cavities are separated only by a very thin partition, usually not quite in the median line. The cavities of the two sides open anteriorly, close together, in the spheno-ethmoidal recess.

The *maxillary sinuses* are the largest of the nasal accessory sinuses. They lie on each side of the lower (and middle) portion of the nasal cavity, beneath the orbits and immediately above the mouth cavity; they are bounded on almost all sides by only very thin bony walls. In each sinus the neighboring infraorbital canal produces an elongated elevation of the medial wall and in the floor the roots of the molar teeth form the so-called alveolar tubercles. The opening of the sinus into the nasal cavity is in the middle meatus; it is a slit-like opening (hiatus semilunaris) in the region of the infundibulum, behind the opening of the frontal sinus; in addition a roundish accessory opening, also into the middle meatus below the infundibulum, may occur, but it is not constant.

Fig. 436. The thyreoid cartilage, from in front. ($^1/_1$)
Fig. 437. The thyreoid cartilage from the left side. ($^1/_1$) * = articular surface on the inferior cornu.
Fig. 438. The cricoid cartilage from behind. ($^1/_1$)
Fig. 439. The cricoid cartilage from the side. ($^1/_1$)
Fig. 440. The left arytaenoid cartilage (with the corniculate cartilage) from in front and from the lateral surface. ($^1/_1$)
Fig. 441. The left arytaenoid cartilage from the medial surface and in front. ($^1/_1$)
Fig. 442. The left arytaenoid cartilage from the lateral surface. ($^1/_1$)
Fig. 443. The cartilage of the epiglottis from behind. ($^1/_1$)

The Larynx.

The Cartilages of the Larynx.

The *thyreoid cartilage*, much the largest of the laryngeal cartilages, consists of two symmetrical, almost quadrangular plates, which are fused together at a right angle (obtuse in the female) in the median line by their anterior edges, forming the *laryngeal protuberance*. Above the line of fusion there is a deep *superior notch* (*incisura*) and below it a very slight *inferior notch* (*incisura*). The posterior edges of the two plates are widely separated and the almost straight posterior border of each is prolonged above and below into a process. The *superior cornu* is the longer and is curved somewhat inwards and backwards; the *inferior cornu* is shorter and curved forwards and inwards; it bears an articular surface for the cricoid cartilage.

The inner surface of the thyreoid cartilage is smooth, but the outer has an elevation, the *superior tubercle,* near the posterior part of its upper border. From this an oblique line runs downward and medially to an *inferior tubercle* on the lower border.

The *cricoid cartilage* has the form of a seal ring, whose broader part, the *lamina*, is behind and the narrower part, the *arch* (*arcus*), in front. The lower borders of the lamina and arch are at about the same level so that the upper border of the arch slopes upward to the lamina. On the outer surface of the arch in the region of its passage into the lamina there is an *articular facet* for the inferior cornu of the thyreoid cartilage. The lamina is three times as high as it is thick and on its upper border it bears *articular facets* for the arytaenoid cartilages.

The *cartilage of the epiglottis* is a thin plate, convex above and in front, concave below and behind. It bears on its posterior surface a ridge (*carina*) and tapers off below into a narrow stalk (*petiolus*), which fastens into the superior incisure of the thyreoid cartilage. It shows numerous small depressions or even perforations.

The *arytaenoid cartilages* are two in number, each having the form of a triangular pyramid. The base has a concave articular facet for articulation with the upper border of the lamina of the cricoid and its anterior angle is prolonged into a pointed process, the *vocal process,* while the blunter lateral angle is the *muscular process*. The lateral surface has a curved ridge, the *arcuate crest,* which begins at the vocal process and passes at first backward and then upward; it separates an upper *triangular fovea* from a lower *oblong fovea*. Above the latter, near the anterior border is a rounded tubercle, the *colliculus*. The posterior surface is concave and the medial, almost flat, is situated in the median plane.

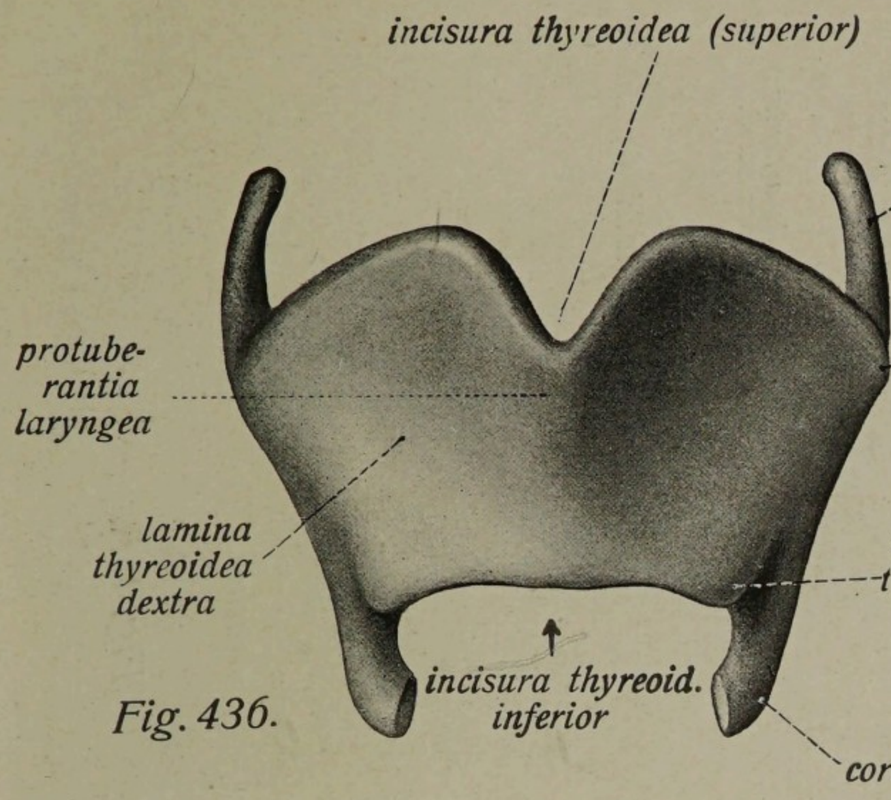


Fig. 436.

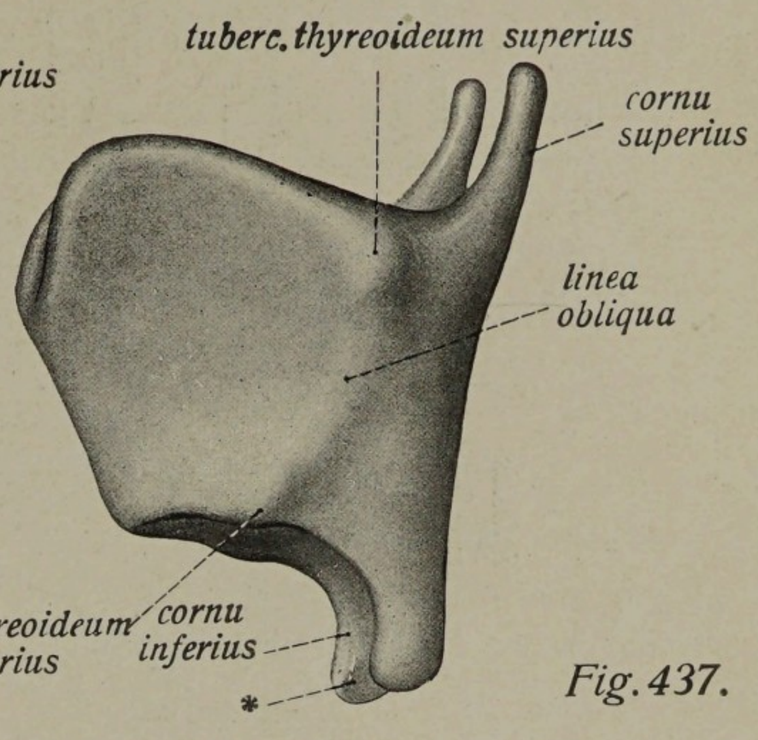
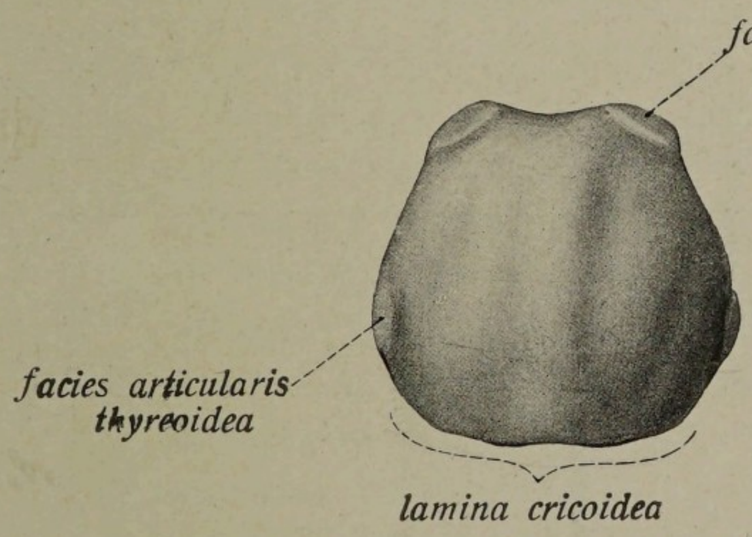


Fig. 437.



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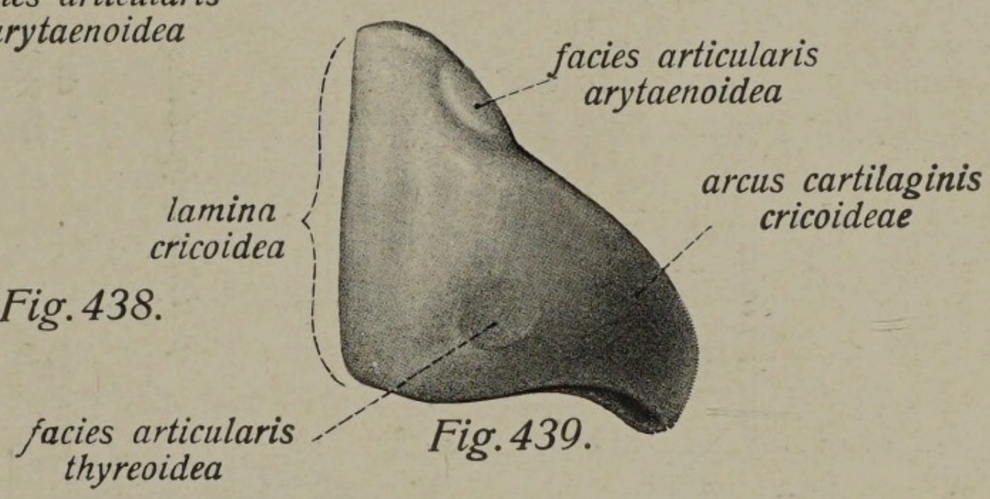

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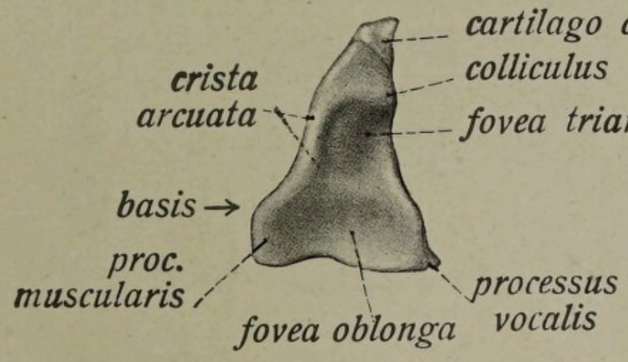

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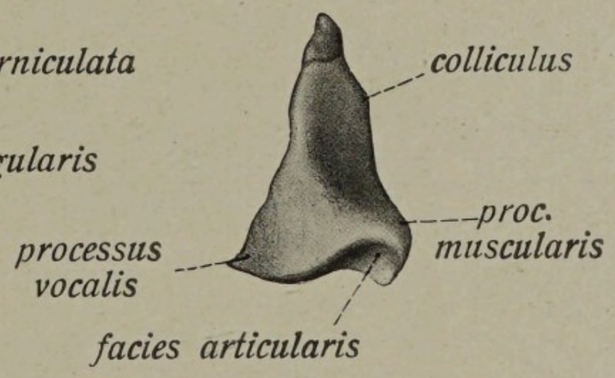


Fig. 441.

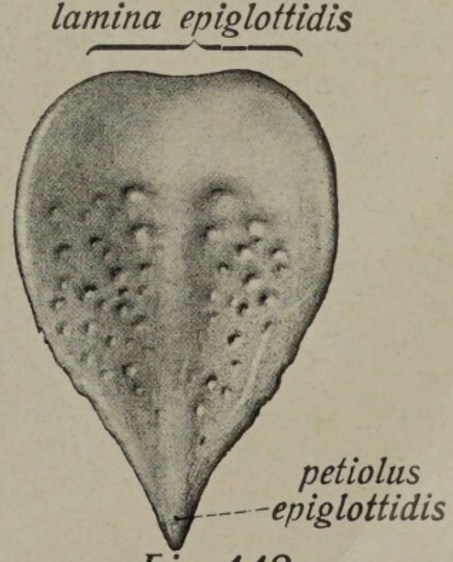
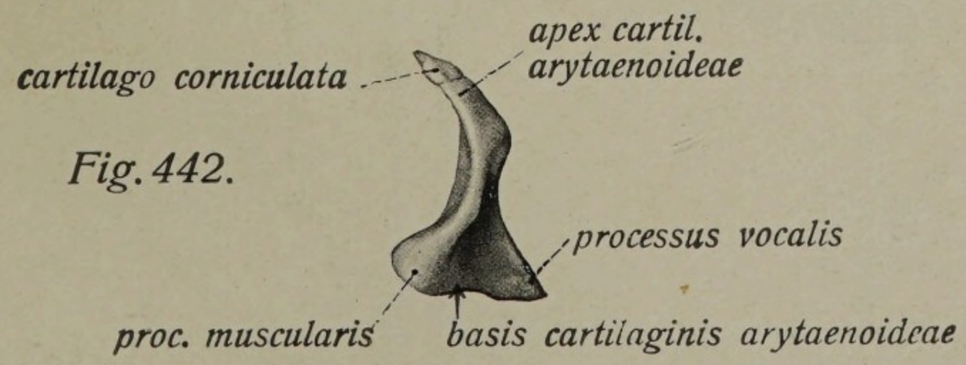


Fig. 443.



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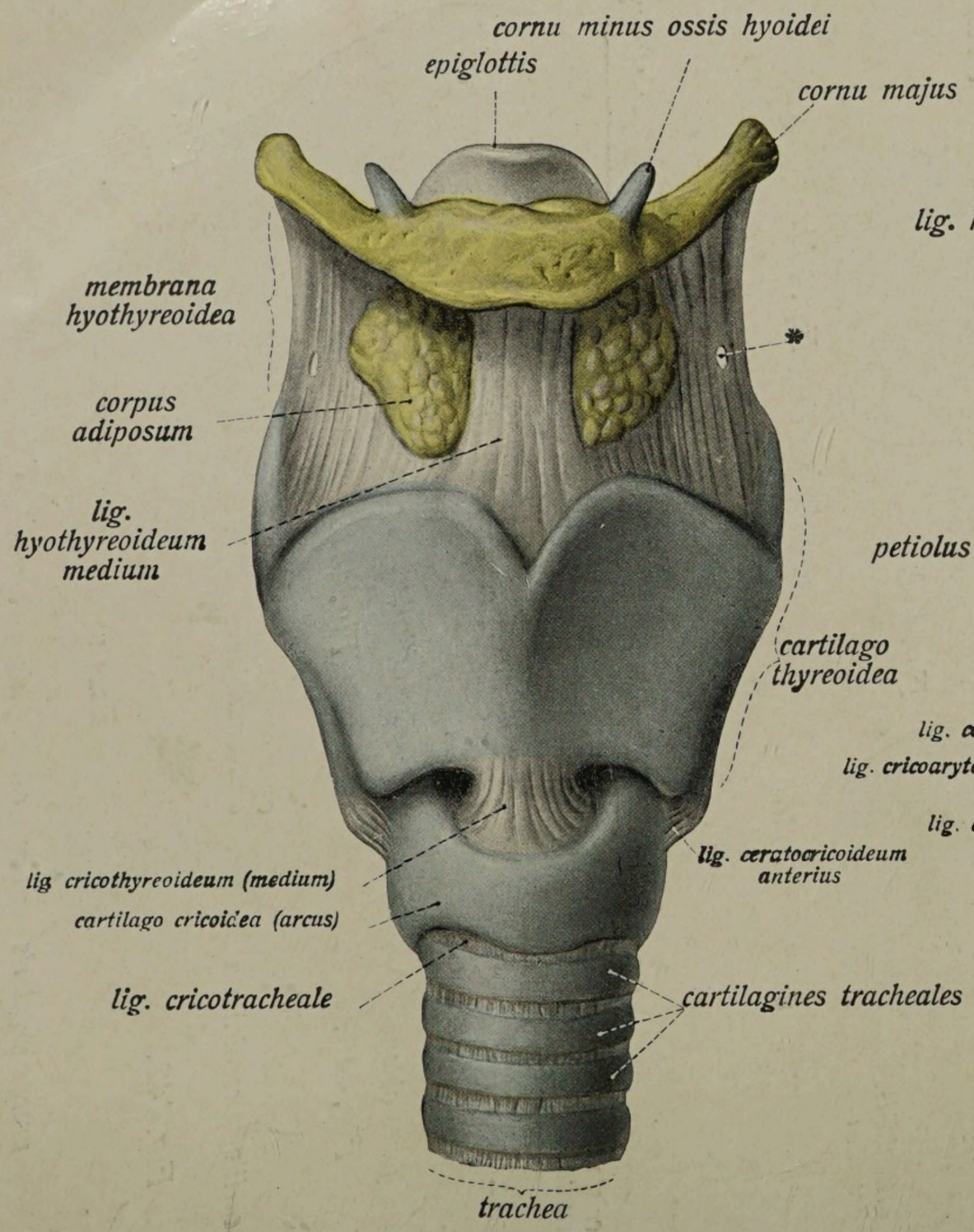

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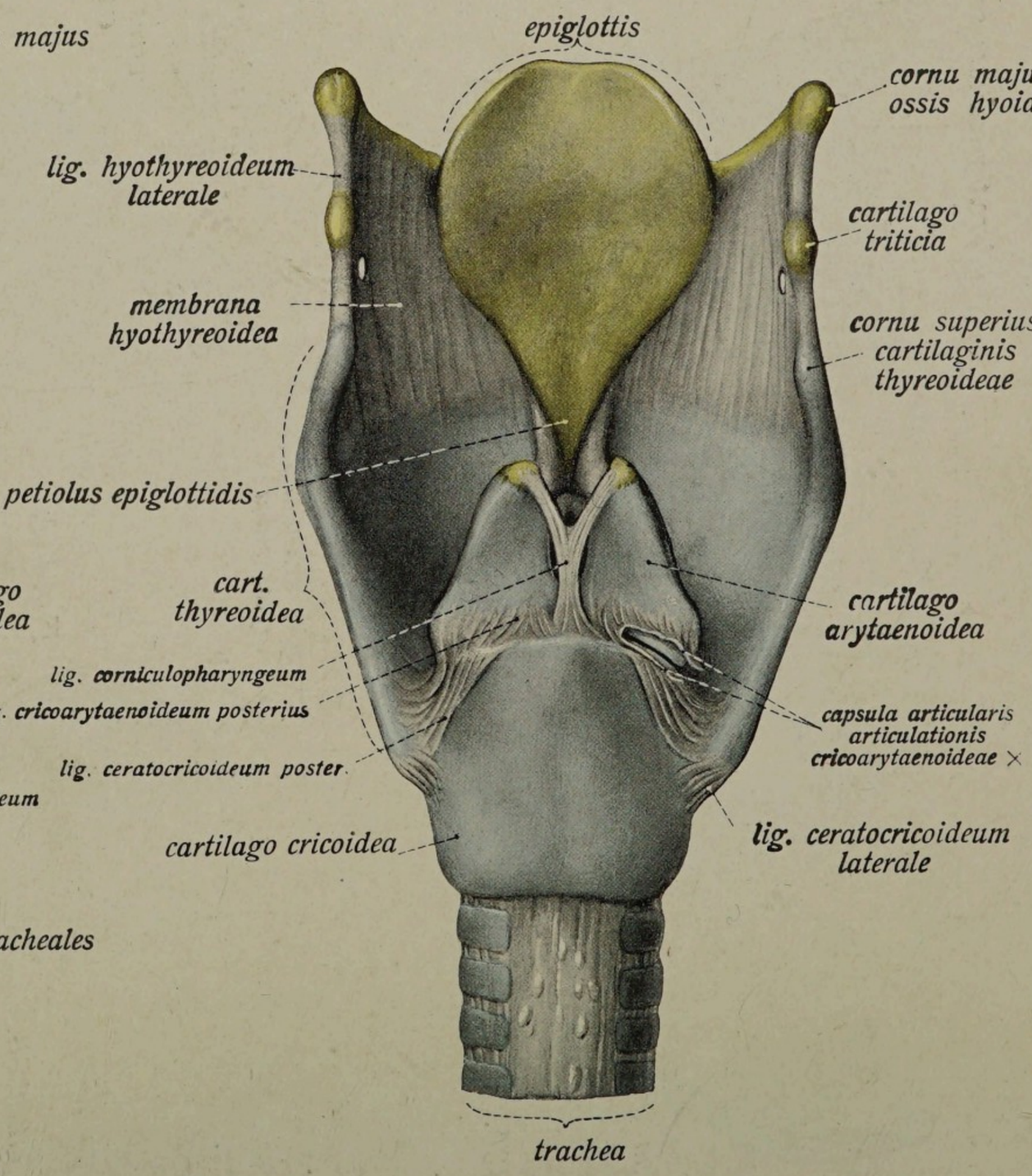


Fig. 445.

Fig. 444. The joints and ligaments of the larynx from in front. (1/1) * = foramen in the thyreo-hyoid membrane for the superior laryngeal nerve.

The Respiratory Organs. The Larynx. (Cont.)

The *corniculate cartilages* (cartilages of Santorini) are small, pyramidal bodies, seated upon the apices of the arytaenoid cartilages. They are directed backward and medianward. The *cuneiform cartilages* (cartilages of Wrisberg) are rod-like cartilages situated in the ary-epiglottic folds near the anterior border of the arytaenoid cartilages; they are inconstant. The roundish *cartilagines triticeae* are also inconstant, but may occur in the lateral hyo-thyreoid ligament.

The Joints and Ligaments of the Larynx.

The paired *crico-thyreoid articulation* is between the inferior cornua of the thyreoid cartilage and the arch of the cricoid. Each is enclosed by an articular capsule and has as reenforcing bands the *lateral, posterior* and *anterior cerato-cricoid ligaments*.

The *crico-arytaenoid articulation,* also paired, is between the base of an arytaenoid cartilage and the upper border of the lamina of the cricoid. The thin articular capsule is reenforced posteriorly by the strong *posterior crico-arytaenoid ligament*.

The *ary-corniculate synchondrosis* is the articulation of the corniculate and arytaenoid cartilages. The lax elastic *hyothyreoid membrane* unites the upper border of the thyreoid cartilage to the lower border of the body of the hyoid bone and to its greater cornua. It is perforated laterally by an opening for the passage of the superior laryngeal nerve. Its middle, firmer portion is termed the middle *hyo-thyreoid ligament,* while the lateral portions, which unite the tip of the greater cornua of the hyoid bone to the superior cornua of the thyreoid cartilage, are known as the *lateral hyo-thyreoid ligaments*. These frequently contain the cartilagines triticeae. On the hyo-thyreoid membrane there is on either side, close to the middle hyo-thyreoid ligament, a constant, flat, lobed mass of fat. The cricoid cartilage is attached to the neighboring trachea by the *crico-tracheal ligament*.

From the tips of the corniculate cartilages an elastic band of fibres extends downwards on either side and unites with that of the other side at the upper border of the lamina of the cricoid cartilage; it is in relation with the mucous membrane of the pharynx, which covers it, and is therefore termed the *crico-pharyngeal ligament*.

Fig. 444. The joints and ligaments of the larynx from in front. ($^1/_1$) * = foramen in the thyreo-hyoid membrane for the superior laryngeal nerve.

Fig. 445. The joints and ligaments of the larynx from behind. ($^1/_1$) Hyaline cartilage is blue, elastic fibro-cartilage and hyoid bone yellow. The right crico-arytaenoid joint is opened.

The Respiratory Organs. The Larynx. (Cont.)

Fig. 446. The muscles of the posterior surface of the larynx. ($^1/_1$)
Fig. 447. The crico-thyreoid muscle from the left side and somewhat from in front. ($^1/_1$)
Fig. 448. The muscles of the larynx from the left side. ($^1/_1$) The greater part of the left lamina of the thyreoid cartilage is cut away.

The Muscles of the Larynx.

The **Crico-thyroideus** arises from the outer surface of the arch of the cricoid cartilage and is inserted into the lower border and inferior cornu of the thyreoid cartilage. It has a superficial straight and a deep oblique portion.

The **Crico-arytaenoideus posterior** arises from the posterior surface of the lamina of the cricoid cartilage and inserts into the muscular process of the arytaenoid cartilage.

The **Crico-arytaenoideus lateralis** arises from the lateral part of the arch of the cricoid and is inserted into the muscular process of the arytaenoid.

The **Arytaenoideus transversus** arises from the lateral border and posterior surface of one arytaenoid cartilage and passes to the corresponding parts of the other.

The **Arytaenoideus obliquus** arises from the muscular process of one arytaenoid and passes to the apex of the other.

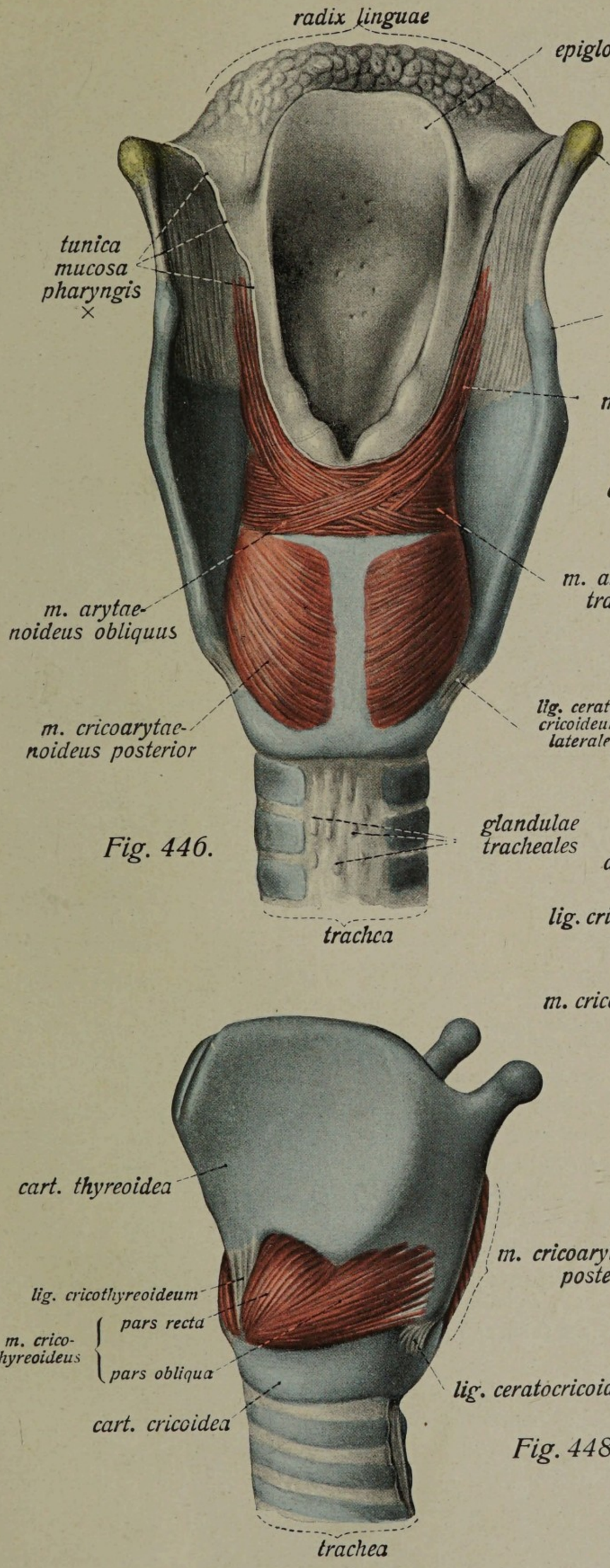
The **Ary-epiglotticus,** variably developed fibres in the ary-epiglottic fold.

The **Thyreo-arytaenoideus** arises from the inner surface of the thyreoid cartilage and inserts into the muscular process and lateral surface of the arytaenoid cartilage. Those fibres that are contained within the vocal fold are sometimes termed the *m. vocalis.*

The **Ventricularis** consists of fibres lying in the false vocal fold *(plica ventricularis).*

The **Thyreo-epiglotticus** is formed by prolongations of the thyreo-arytaenoideus into the ary-epiglottic fold.

The Crico-thyreoideus is supplied by the superior laryngeal nerve, all the other muscles by the inferior laryngeal. The Crico-thyreoideus tenses the vocal cords and the Thyreo-arytaenoideus relaxes them; the Crico-arytaenoideus posterior widens and the lateralis narrows the rima glottidis. The remaining muscles act as constrictors of the entrance to the larynx and of the rima glottidis.



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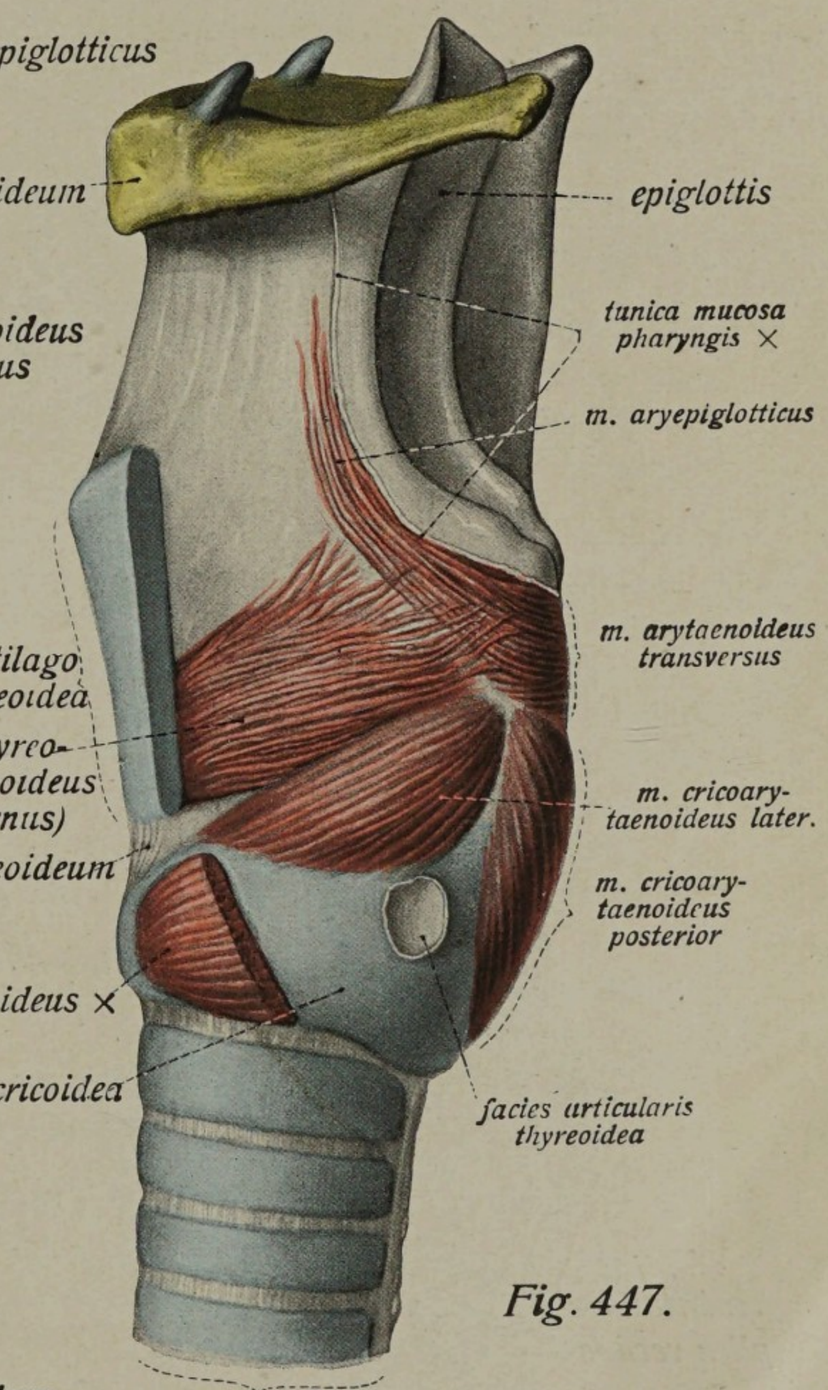

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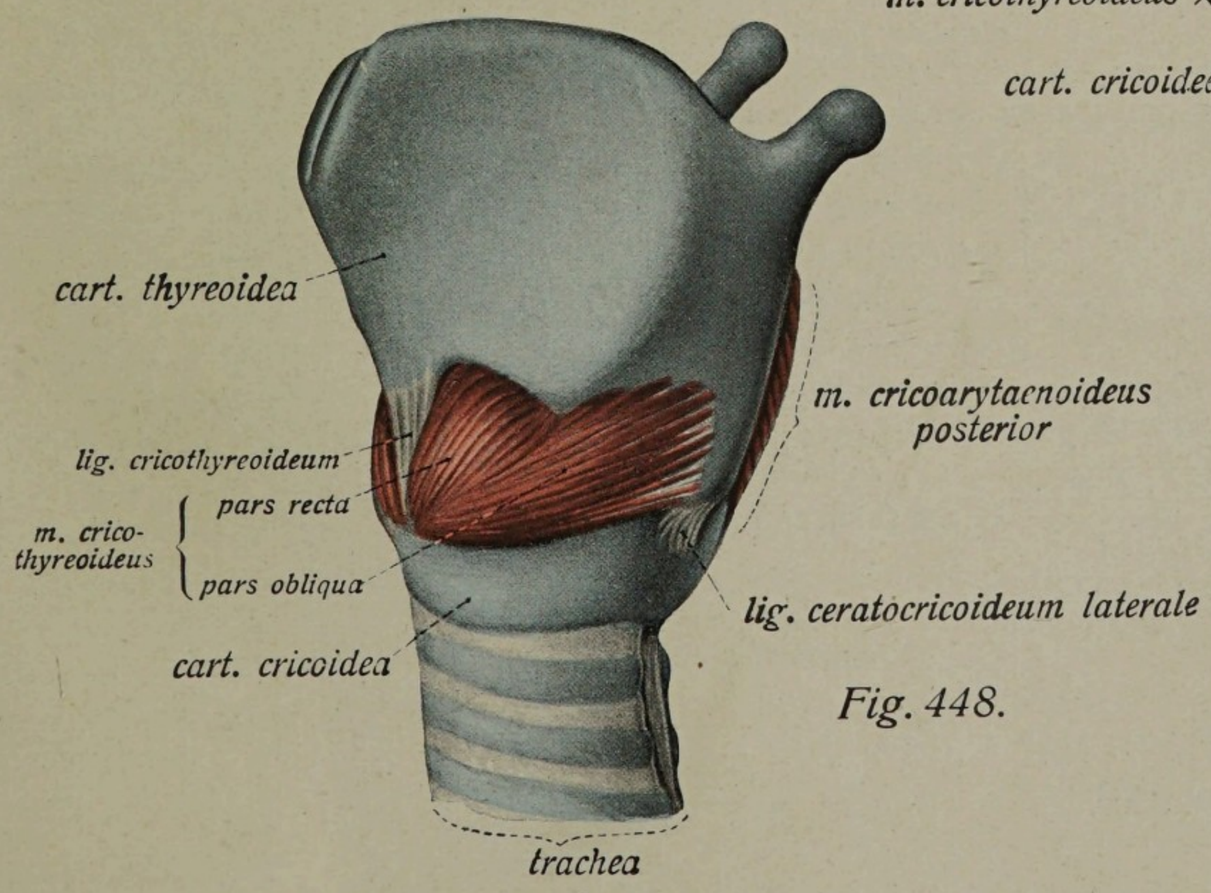

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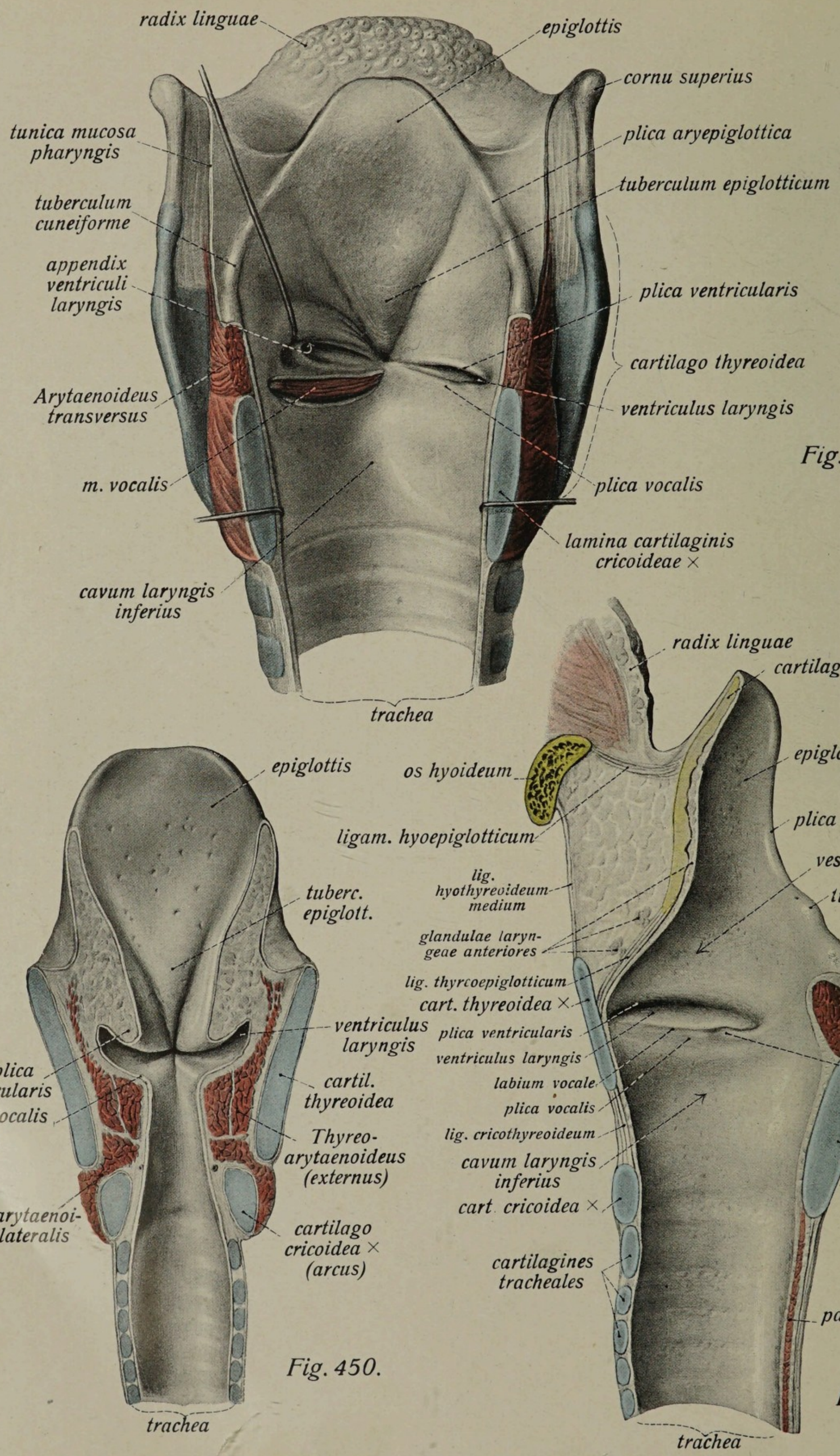


Fig. 449

Fig. 450.

Fig. 451.

The Respiratory Organs. The Larynx. (Cont.)

Fig. 449. The larynx opened from behind in the median line. ($^1/_1$) The left false vocal cord is drawn upwards, the mucous membrane of the left true vocal cord is divided.
Fig. 450. A frontal section of the larynx. ($^1/_1$)
Fig. 451. A sagittal section of the larynx. ($^1/_1$) * = position of the tip of the vocal process.

The epiglottis is fastened by its anterior surface to the upper border of the body of the hyoid bone by the broad *hyoepiglottic ligament* and the petiole is seated in the superior thyreoid notch by means of the *thyreo-epiglottic ligament*.

On the outer surface of the larynx there is a strong elastic band, the *crico-thyreoid ligament*, which connects the inferior thyreoid notch with the upper border of the arch of the cricoid cartilage; it forms the anterior end of the *elastic cone*.

This is an especially strong portion of the elastic lining of the larynx; it lies immediately beneath the mucous membrane and has the form of a short conical tube. It begins at the upper border of the cricoid cartilage and extends upwards, diminishing in size, to the arytaenoid cartilages and to the *vocal cords* (vocal ligaments), which are paired thickened strips of the elastic cone and arise close together from the inner surface of the angle of the thyreoid cartilage. They pass backwards, almost parallel with one another and close to the median line, to the vocal process of the arytaenoid cartilage. Above and parallel with them are the weaker, less elastic, but somewhat longer *false vocal cords (ventricular ligaments)*.

The Mucous Membrane of the Larynx.

The mucous membrane of the larynx follows as a whole, even as to individual folds, the relief of the skeleton of the larynx ond of the elastic cone. The epiglottis is attached to the tongue by the *median* and *lateral glosso-epiglottic folds*, between which, on either side, there is a depression, the *epiglottic vallecula*. Furthermore, from the epiglottis two folds, the *ary-epiglottic folds*, pass backward to the tips of the arytaenoid and corniculate cartilages and form the lateral boundaries to the entrance *(aditus)* of the larynx; in addition to muscle fibres (ary-epiglottic) they usually contain the cuneiform cartilages. Upon each of them are to be seen two knob-like elevations of the mucous membrane, one, the *corniculate tubercle*, over the corniculate cartilage and the other, the *cuneate tubercle*, over the cuneiform cartilage.

From the entrance to the larynx the mucous membrane extends down into the actual cavity of the larynx, which it lines. The most important structure shown by the mucosa in this region is the vocal organ, the *glottis*. It lies at about half the height of the larynx and consists of the two vocal lips *(labia vocalia)* and the *rima glottidis*. The vocal lips are formed by the mucous membrane covering the vocal cords and the vocal muscles; their free borders are termed the *plicae vocales*. Posteriorly they contain the vocal processes of the arytaenoid cartilages. The glottis divides the cavity of the larynx into two portions, an upper *vestibule* and an *inferior cavity* of the larynx.

The rima glottidis is divided into a short posterior, but wider *intercartilaginous part*, in which lie the vocal processes of the arytaenoid cartilages, and a longer, anterior and narrower *intermembranous part*, bounded laterally by the vocal ligaments and the mucosa covering them. Both parts are quite distinct when in the relaxed condition (as in the cadaver), since the tips of the vocal processes show through as yellowish points. At the anterior part of the vocal lips, just before their attachments to the thyreoid cartilage, there is a constant *yellow spot (macula flava)*.

The Respiratory Organs. The Larynx. (Cont.)

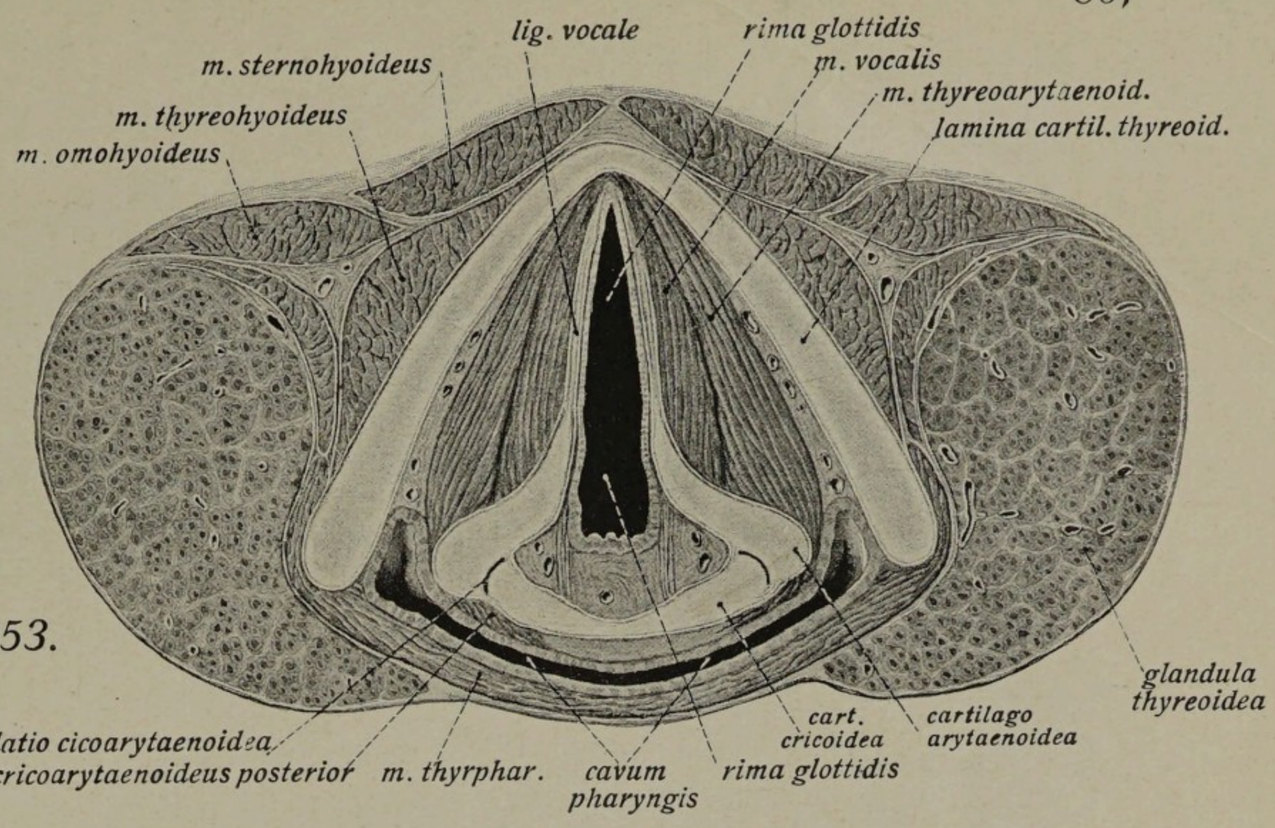
Fig. 452. The entrance to the larynx from behind and above. ($^1/_1$)
Fig. 453. A transverse section through the larynx and thyreoid gland at the level of the glottis. ($^1/_1$)
Fig. 454. The hyoid bone, the larynx, the trachea and its principal branches, from in front. ($^3/_4$)

The *false vocal folds (plicae ventriculares)* are folds of mucous membrane parallel to the vocal lips. They are formed by the mucous membrane covering the false vocal cords (ventricular ligaments and muscles). Between their free edges there is a relatively wide cleft, the *rima vestibuli*, whose width is not alterable. In the phonation position it is markedly wider than the rima glottidis, so that on looking into the entrance of the larynx one can see the vocal lips. Between the true and the false vocal folds there is a lateral evagination of the laryngeal cavity, the *ventricle of the larynx (ventricle of Morgagni)*, from the upper wall of which a blind prolongation, the *appendix of the ventricle*, extends upwards behind the anterior end of the false vocal cord to the posterior surface of the thyreoid cartilage. The mucosa of the portion of the larynx below the glottis covers smoothly the elastic cone. The part of the cavity immediately below the glottis is termed the *inferior entrance (aditus)* of the glottis. In the vestibule on the anterior wall there is an *epiglottic tubercle* corresponding to the base of the petiole of the epiglottis.

The Trachea and Bronchi.

The trachea is a rather firm tube, 10—20 cm long and 11—18 mm in diameter. It takes origin from the larynx opposite the fibrocartilage between the sixth and seventh cervical vertebrae and extends to the level of the fibrocartilage between the fourth and fifth thoracic vertebrae. At this level or that of the fifth thoracic vertebra, it divides almost at a right angle, into the two bronchi, of which the *right bronchus* is the wider but shorter and the *left bronchus* the narrower and longer.

The skeleton of the trachea consists of 16—20 cartilaginous rings, the *tracheal cartilages*, which are open behind. They from the anterior and lateral walls of the trachea, while the posterior wall contains no cartilaginous skeleton but consists mainly of smooth muscle fibres which extend between the ends of the rings.



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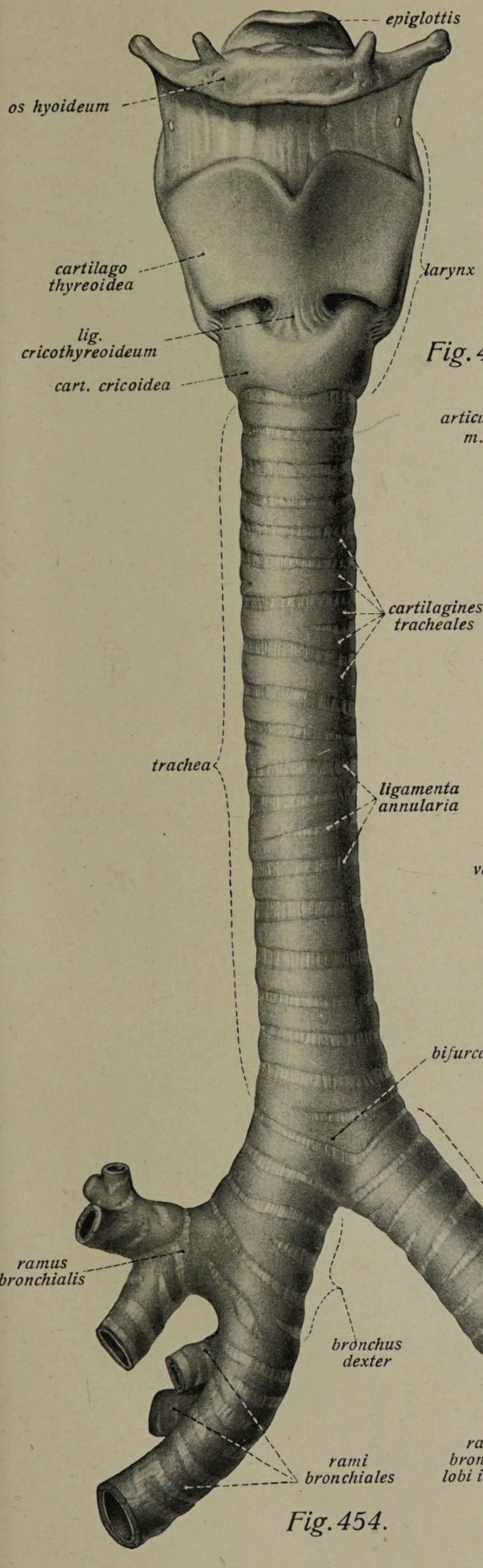

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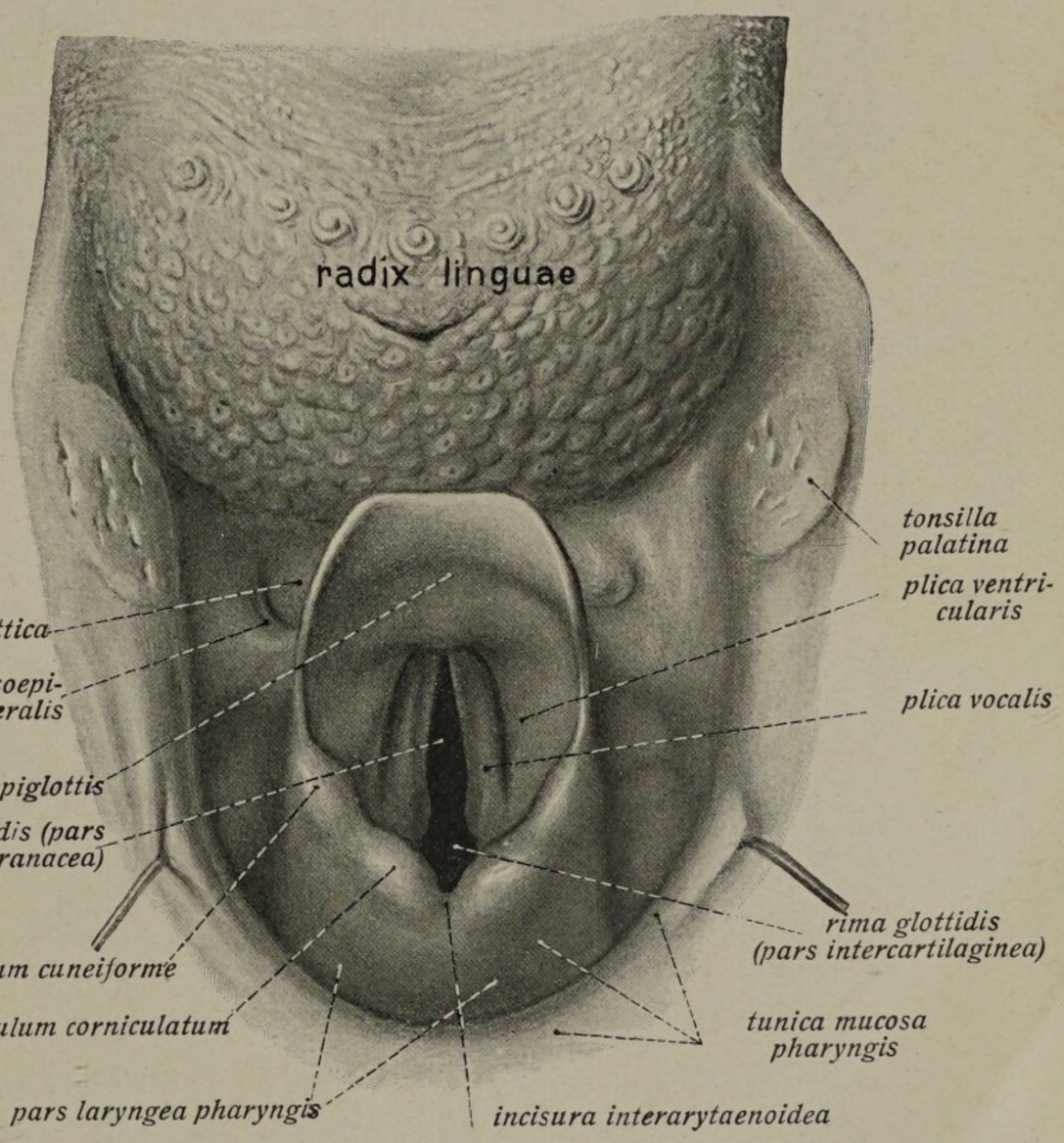

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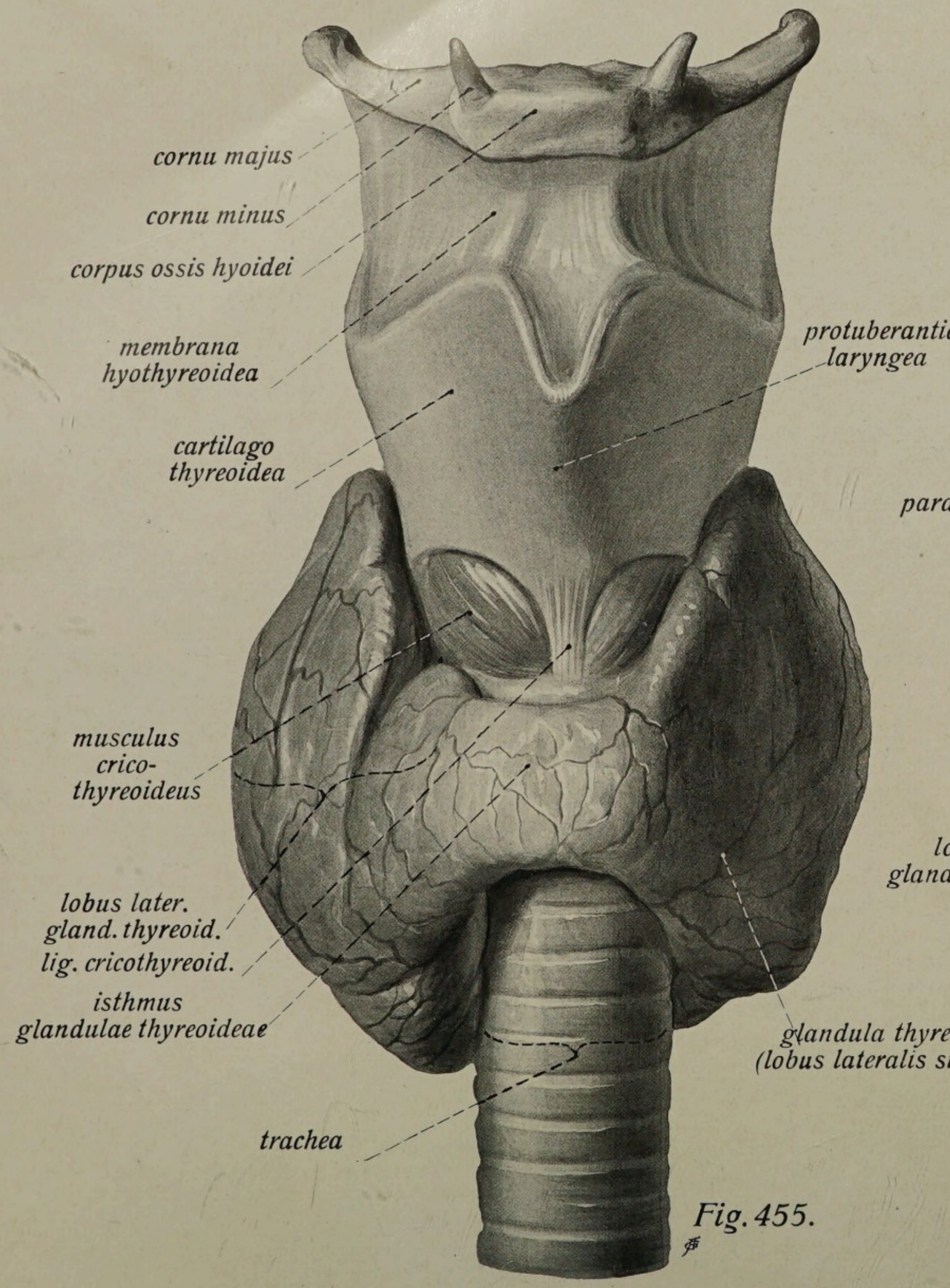

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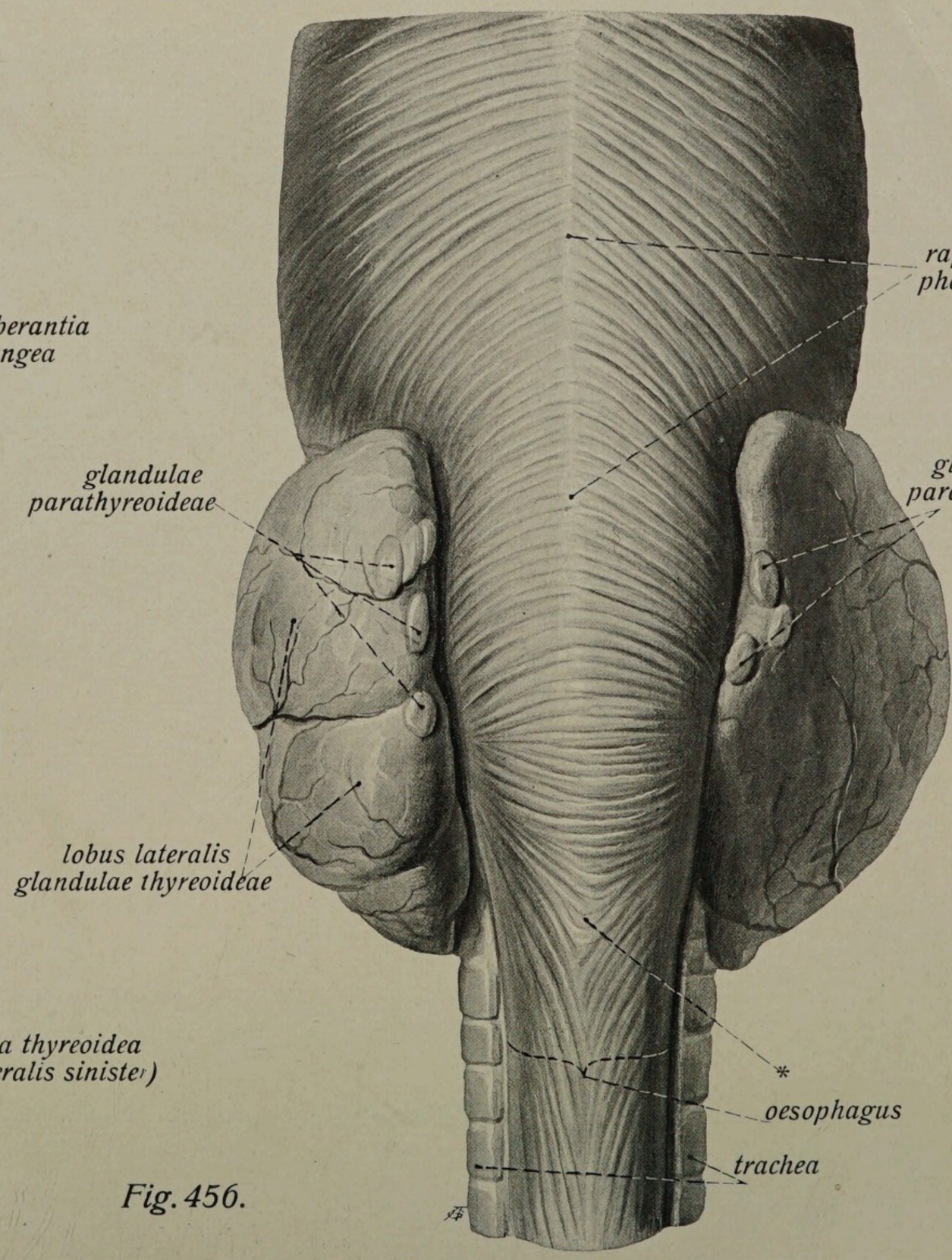


Fig. 456.

The Respiratory Organs. The Thyreoid Gland.

Fig. 455. The thyreoid gland, larynx, upper portion of the trachea and the hyoid bone from in front. ($^1/_1$)

Fig. 456. The thyreoid and parathyreoid glands with the lower portion of the pharynx and upper end of the oesophagus from behind. ($^1/_1$) * = boundary between pharynx and oesophagus.

The Thyreoid Gland.

The *thyreoid gland* is one of the ductless glands. It lies in the neck in front of the upper part of the trachea and in front of the lateral parts of the lower portions of the larynx. In its middle portion it is covered by the superficial and deep layers of the cervical fascia, in its lateral portions by the two sternothyreoid muscles, which lie directly on the gland, and by the other infra-hyoid muscles.

It is unpaired, has a horseshoe shape and consists of a small median portion, the *isthmus*, and two lateral *lobes*.

The flattened isthmus lies in front of the upper three or four tracheal cartilages and, when well developed, also in front of the crico-tracheal ligament and the arch of the cricoid cartilage. In correspondence with the form of the trachea it is convex in front and concave behind. Not infrequently an unpaired, usually flat process, the *pyramidal lobe*, arises from it, extending upward to the body of the hyoid bone and tapering as it goes.

The much more voluminous and markedly thicker lobes lie to the sides of the lower portion of the larynx and the upper portion of the trachea. Below their ends are rounded and do not extend much below the level of the lower border of the isthmus, but above they end in strongly rounded tips considerably above the upper border of the isthmus. Behind they reach the lateral walls of the laryngeal portion of the pharynx and the upper portion of the oesophagus. Frequently the two lobes differ in size.

The surface of the gland usually appears distinctly lobed, its color is greyish-red and in section it shows fine vesicles, filled with colloid, which appear as dots or of the size of millet seed.

Frequently there is a more or less distinct line of separation between the lobes and the isthmus and in other respects also the isthmus seems to possess a certain independence of the lobes, being occasionally quite rudimentary or even entirely absent.

In addition to the main gland there are occasionally *accessory thyreoid glands*, which are to be regarded as portions of the inconstant pyramidal lobe. They sometimes extend up to the hyoid bone. Not to be confused with these are the *parathyreoid glands* which are constant epithelial bodies, two or three in number, situated on the posterior surface of the lobes of the thyreoid gland, on branches of the inferior thyreoid artery. They are only topographically related to the thyreoid gland, and lie outside its connective tissue capsule.

The Respiratory Organs. The Thyreoid Gland. (Cont.)

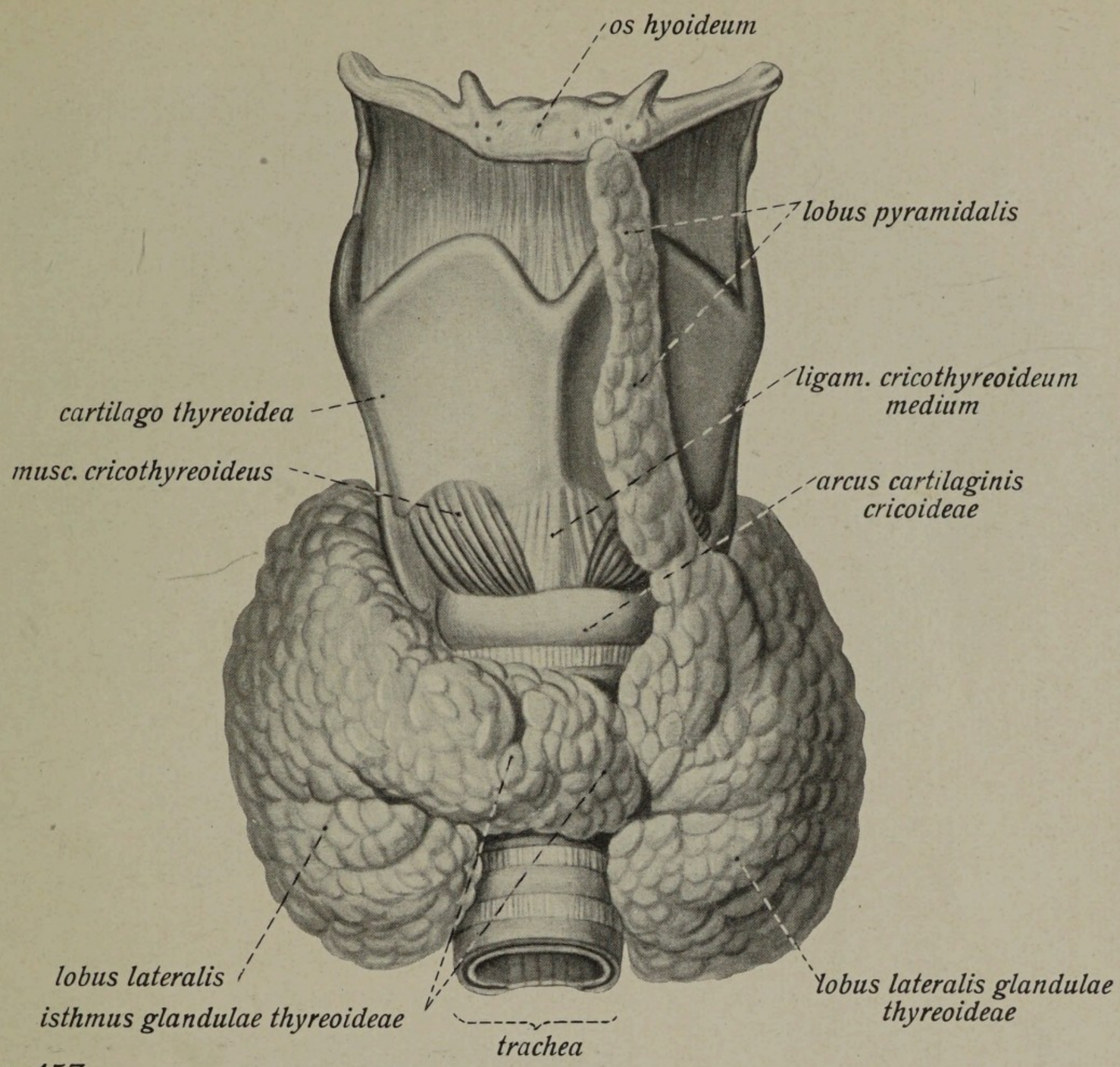
Fig. 457. The thyreoid gland in its relations to the trachea and larynx, from in front. ($^1/_1$) The gland, divided by deep notches, shows a well developed pyramidal lobe, arising from the left lobe and extending upwards to the hyoid bone. The isthmus is also exceptionally large.

Fig. 458. A horizontal section of the thyreoid gland, the trachea, and the oesophagus at the level of the second ring of the trachea. ($^1/_1$) The section passes through the isthmus of the thyreoid gland and shows clearly the investment of the gland by a connective tissue capsule and its topographic relations. * = interior epithelial body, ** = sheet of the cervical vessels.

The pyramidal lobe, which not infrequently occurs as a variation, is to be regarded as the remains of the original embryonic duct of the gland. Since the foramen caecum of the tongue and the thyreo-glossal duct that occasionally continues this deeply, mark the spot from which the embryonic gland arises, the pyramidal lobe also often extends upwards to the hyoid bone. As a result of the partial degeneration of the pyramidal lobe the frequently occurring accessory thyreoids (see p. 369) are formed.

The thyreoid gland is enclosed within a connective tissue capsule, which takes origin from the cervical fascia; it sends septa into the substance of the gland, dividing it into various lobes. By means of this capsule and ligamentous prolongations from it the gland is attached to the cricoid cartilage and to the upper rings of the trachea; two lateral ligaments, which attach the medial surfaces of the lateral lobes to the trachea, are stronger than a middle one, passing to the posterior surface of the isthmus.

In addition there may be suspensory muscles of the thyreoid gland; as a rule these are aberrant fibres of the Cricothyreoideus or Thyreo-hyoideus (more rarely of the Constrictor inferior of the pharynx).



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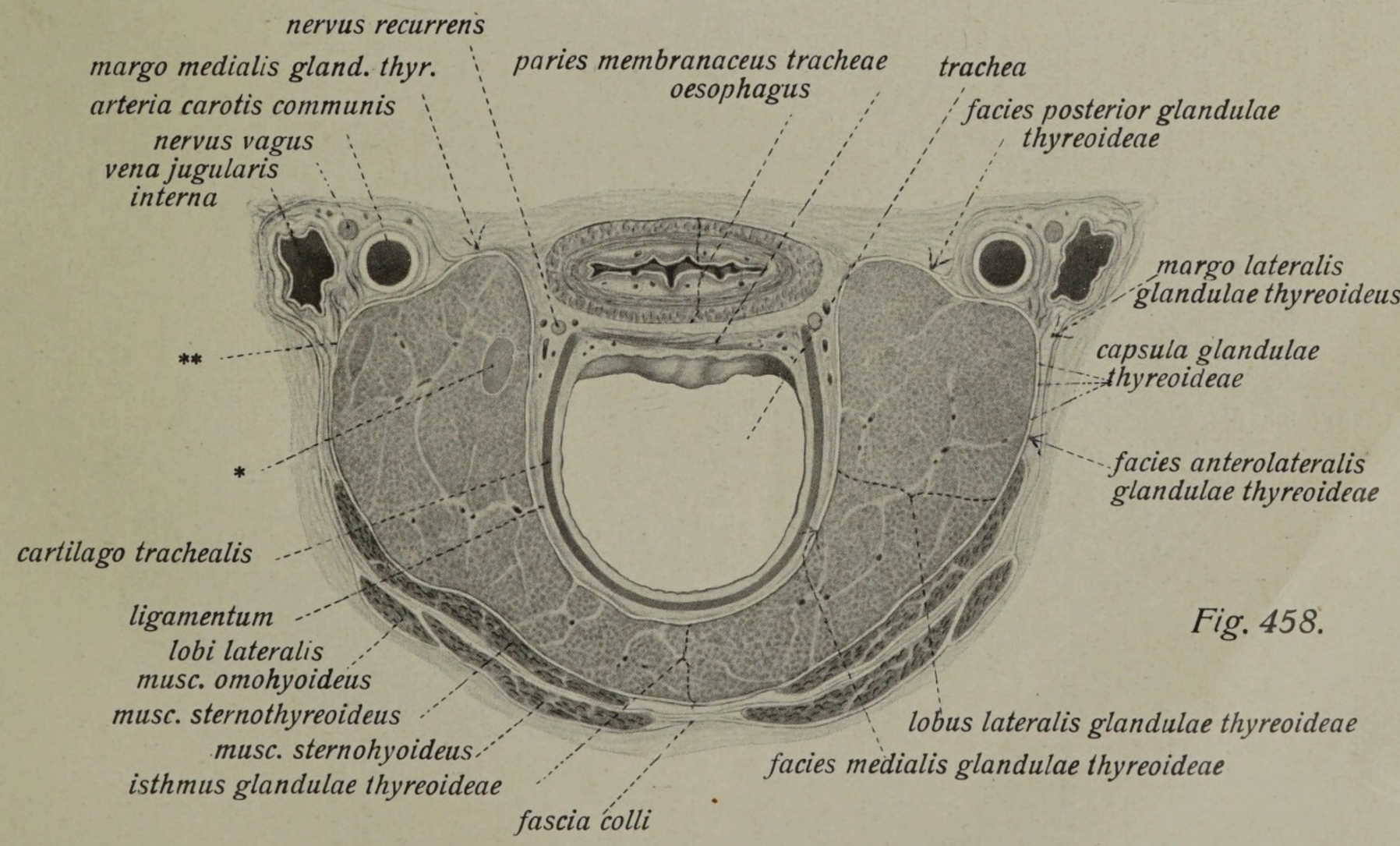

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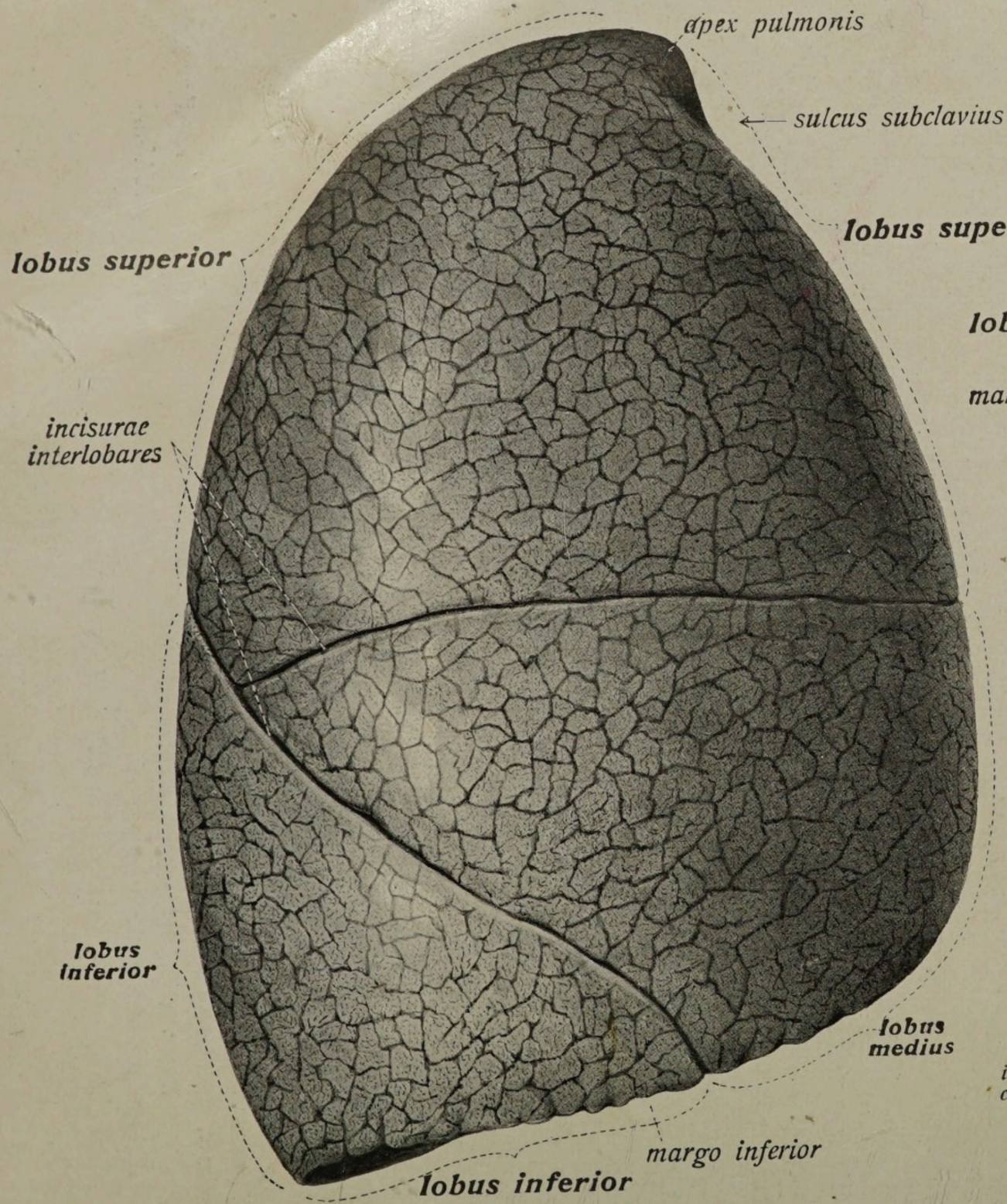

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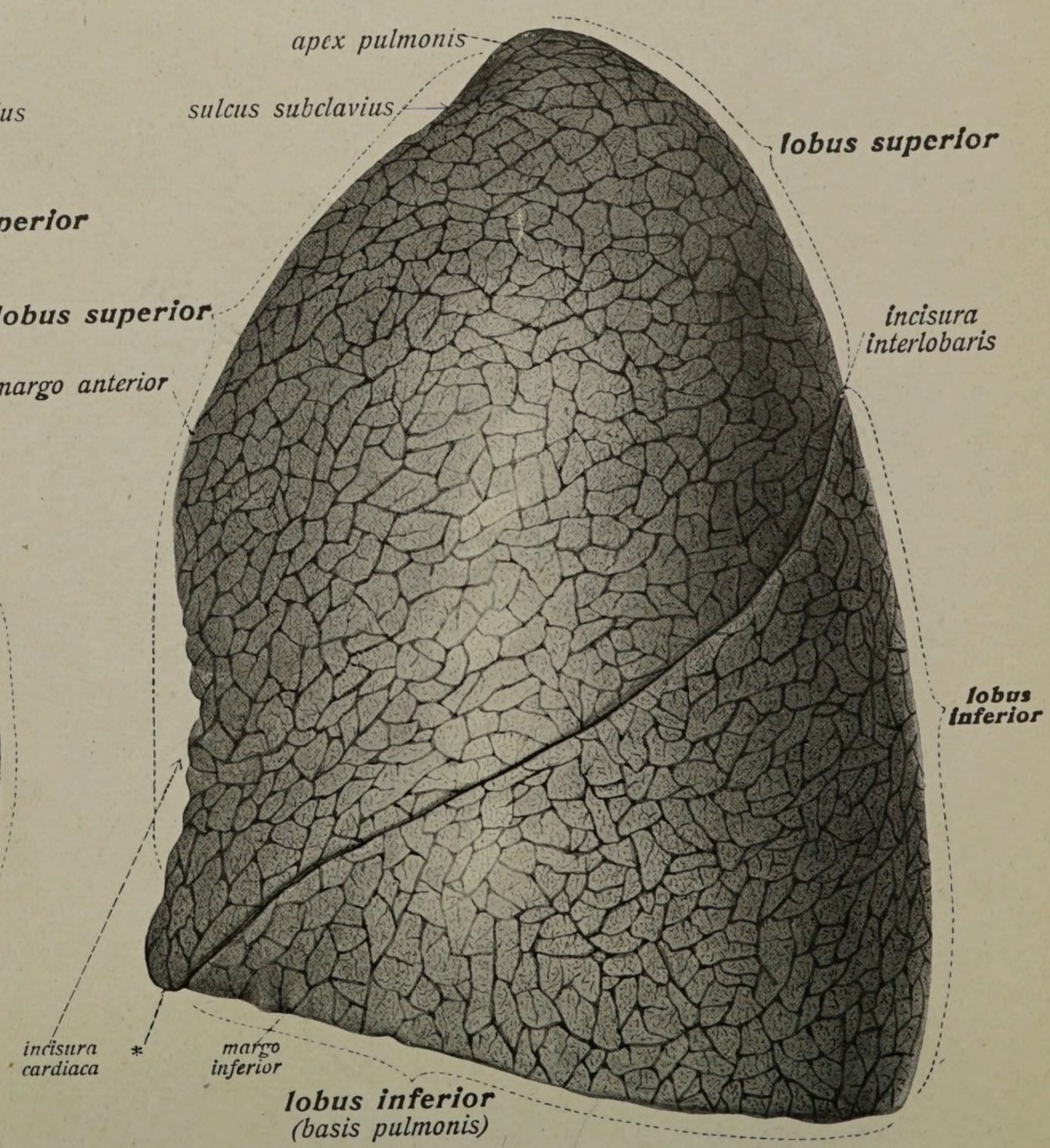


Fig. 460.

Fig. 459. The right lung, lateral (costal) surface. (2/5)

The Respiratory Organs. The Lungs.

The Lungs, *pulmones.*

There are two lungs, a right *(pulmo dexter)* and a left *(pulmo sinister).* They are quite similar, but the right is more voluminous than the left.

The *base* of the lung is a strongly concave surface, the *diaphragmatic surface,* resting upon the cupola of the diaphragm. The rounded *apex,* directed upwards, has, in the case of the left lung, a shallow, broad groove for the subclavian artery on its medial surface.

The extensive, convex surface which is turned towards the ribs and is directed mainly laterally is termed the *costal surface,* while that opposite, the smaller medial and mostly concave surface facing the heart, is the *mediastinal surface.* The costal and diaphragmatic surfaces are separated by a very sharp *inferior border;* the mediastinal and lateral surfaces by the also thin but less smooth *anterior border.*

The mediastinal surface of the lung, which is practically in the sagittal plane, shows at about its middle and towards the anterior border a *cardiac impression.* Owing to the unsymmetrical position of the heart this is neccesarily greater on the left lung than on the right one. The portion of the surface behind the impression is in part convex, but shows a vertical furrow, which in the left lung is due to the aorta and in the right to the vena azygos.

In the posterior part of the cardiac impression there is a slightly depressed, pear-shaped area, with its small end directed upwards; it is the *hilus* and gives entrance to the vessels and bronchi. The surface of the lung up to the hilus is covered by peritoneum, the *pleura,* and is therefore smooth as glass. On the reddish-grey surface dark, blue-black to black lines, which mark out the individual pulmonary lobules, may be seen and, further, certain deep fissures, the *interlobar incisures,* which separate the various lobes and pass deeply into the substance of the lungs. The pleura extends into the depth of the interlobar fissures, even almost to the hilus, so that the individual lobes are continuous only to a small extent. The fissure between the middle and upper lobes of the right lung is not so deep as the others. (see p. 374.)

Fig. 459. The right lung, lateral (costal) surface. ($^2/_5$)
Fig. 460. The left lung, lateral surface. ($^2/_5$) * = tongue-shaped process of the upper lobe of the left lung which rests on the pericardium.

The Respiratory Organs. The Lungs. (Cont.)

The larger right lung is divided by two fissures into three *lobes*, *upper*, *middle* and *lower;* the smaller left lung on the other hand has only an *upper* and *lower lobe*, corresponding to the occurrence of only one interlobar fissure. This runs obliquely from behind and above, downwards and forwards, beginning above at the level of the third rib and ending at the lower border of the lung in such a manner that the most anterior portion of the border belongs to the upper lobe. (*) The fissure is to be seen on the costal and mediastinal surfaces (except at the hilus) and for a slight extent also on the diaphragmatic surface. Of the interlobar fissures of the right lung that which separates the upper and middle lobes from the lower one corresponds in its position to the fissure of the left lung, except that above and behind it begins a little lower down and reaches the base and the lower border further lateral than in the left lung. This fissure is markedly deeper than the other one of the right lung and is to be seen on the costal, mediastinal and diaphragmatic surfaces. The second fissure of the right lung, separating the upper and middle lobes, is shorter than the other and at the same time shallower, and is almost at right angles to it. It is visible only on the costal and the anterior part of the mediastinal surface, and not at all on the diaphragmatic surface. The upper lobe on the right lung consequently does not reach the base of the lung as does that of the left lung. The anterior border of the right lung is almost straight, but that of the left lung has an incision, the *cardiac incisure*, which allows the pericardium to be seen. The lower, anterior end of the upper lobe of the left lung projects below this incisure into a small tongue-like lobe, the so-called *lingula* (*), which rests on the pericardium.

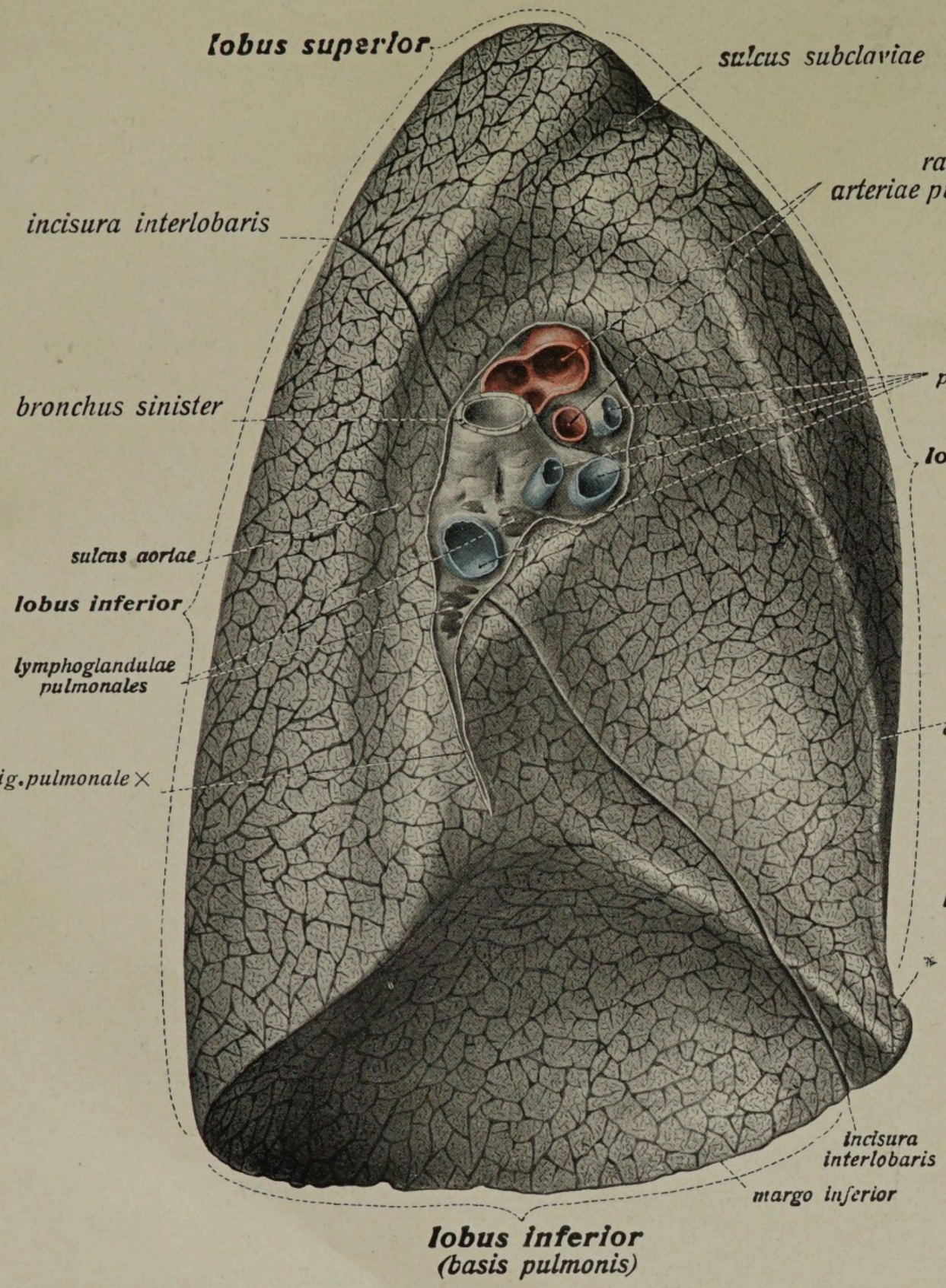
The hilus of each lung remains free from investment by the pleura; from its lower end the attachment of the *ligamentum pulmonale* extends downwards. In the hilus, in addition to the vessels and the bronchi which form the *root (radix)* of the lung, there are also small *pulmonary lymph nodes (lymphoglandulae)*. The vessels and the bronchi are so arranged at the hilus that the branches of the pulmonary anterior are placed most anteriorly and the bronchi most posteriorly and below; only in the right lung is there an eparterial bronchus (see p. 377).

* = tongue-like projection of the upper lobe that rests on the pericardium.

Fig. 461. The left lung, medial (mediastinal) surface. ($^2/_5$)

Fig. 462. The right lung, medial surface. ($^2/_5$)

Fig. 462. The right lung, medial surface. (2/5)



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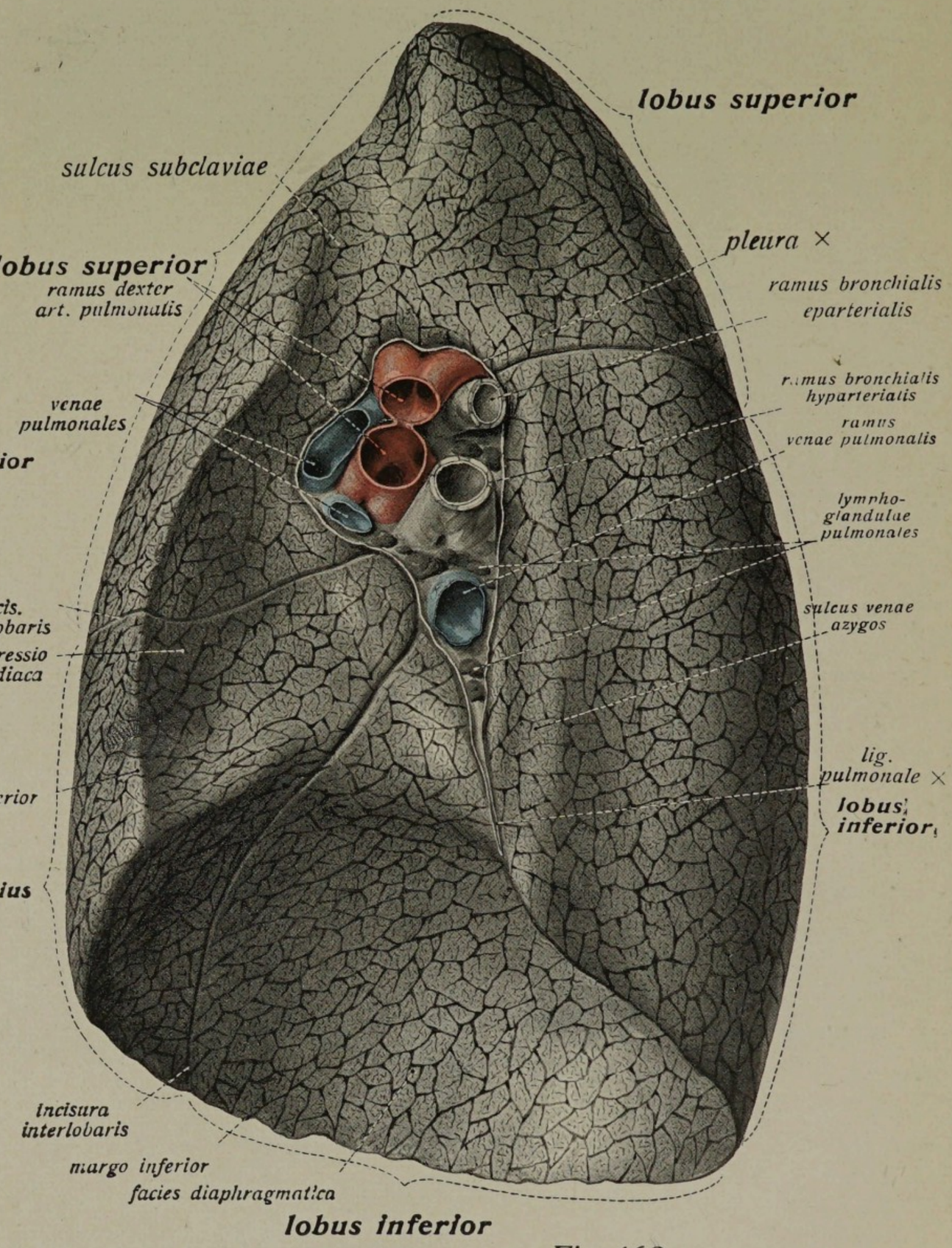

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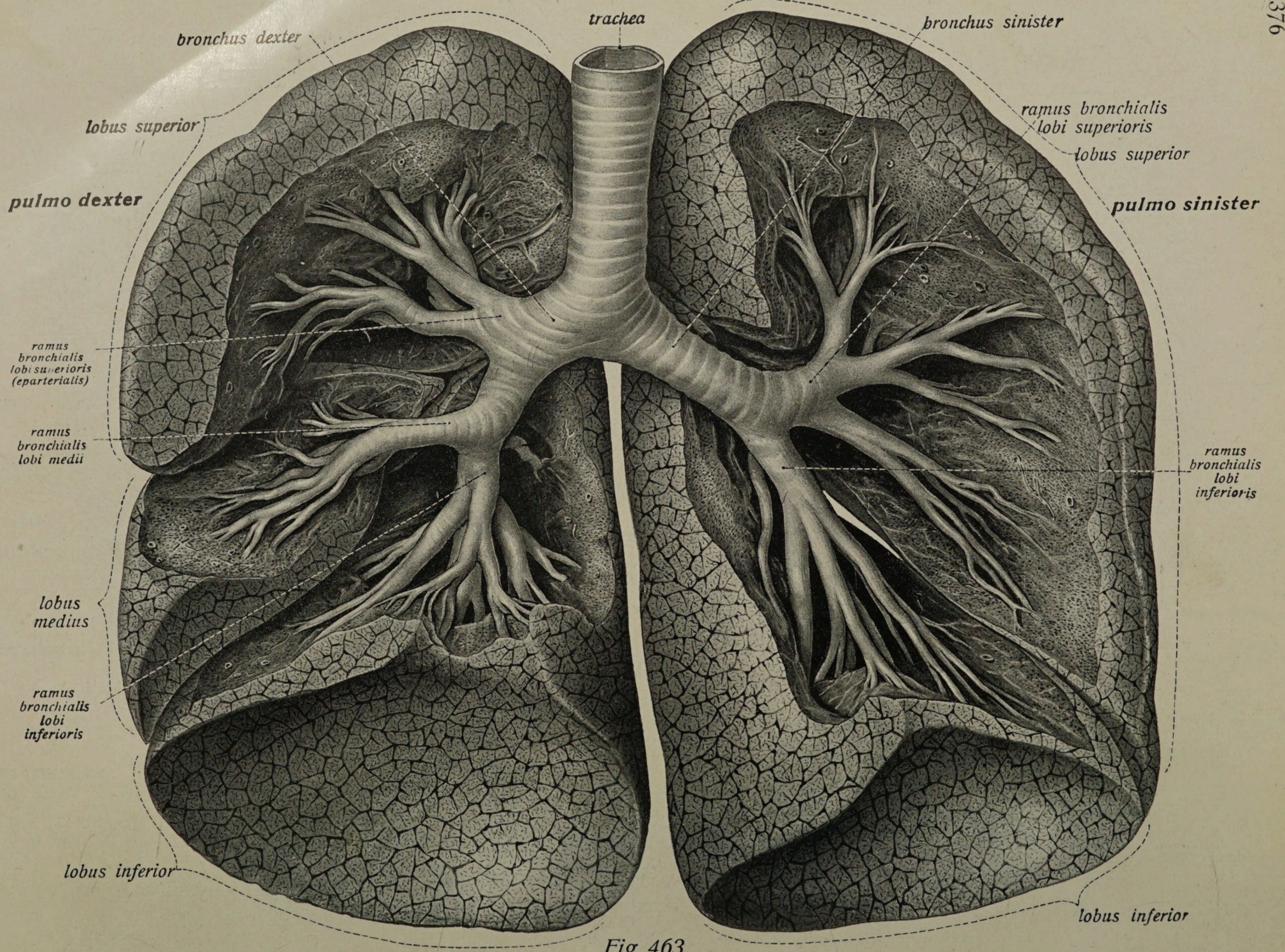


Fig. 463.

Fig. 463. The two lungs with the trachea and the branching of the bronchi,

The Respiratory Organs. The Lungs. (Cont.)

Even before the bronchi reach the hilus of the lung they begin to give off branches *(rami)*, which are divisible, according to their relation to the pulmonary artery in the hilus, into *eparterial* and *hyparterial* branches. Only the branch to the upper lobe of the right lung is eparterial, i. e. it passes into the lung above the branch of the pulmonary artery, while the rest of the bronchial rami of the right lung and all those of the left lung are hyparterial.

The further branching of the bronchial rami takes place within the lung. As the branches diminish in caliber longitudinal folds of the mucous membrane, quite lacking in the larger branches, become more and more evident and more numerous; in the smallest branches these folds are exceptionally distinct. The branching of the bronchi in the lungs is irregularly dichotomous; an actual so-called stem bronchus, which represents the continuation of the main bronchus, cannot be distinguished.

Sections of the lung reveal, in the first place, the boundaries of the individual lobuli, formed by delicate strands of connective tissue and, secondly, sections of the bronchial rami and the larger vascular branches. It is a rule that the arterial and bronchial branches run together, while the stronger branches of the veins pursue a different course. The bronchial branches are distinguishable from those of the arteries by the occurrence in their walls of plates of cartilage. Very frequently there are deposits of black pigment (carbon particles) in the peribronchial connective tissue.

In the individual lobes sections of the alveoli as well as those of the bronchioles can be seen with the aid of a lens; they are not visible to the naked eye.

Fig. 463. The two lungs with the trachea and the branching of the bronchi, exposed by removing portions of lung substance. From in front. (2/3)

The Respiratory Organs. The Lungs. Appendix: the Thymus Gland.

The Thymus Gland.

The thymus gland is a peculiar glandular (perhaps only gland-like) organ, which is much more strongly developed in young individuals than in adults. It shows its relatively greatest size in the new-born child; then its growth becomes retarded, although until puberty it increases in absolute size. Thereafter a complete cessation of growth occurs to which succeeds a gradual process of degeneration, which does not, however, lead to a complete disappearance of the gland, even in the adult; as a rule it no longer appears as a compact organ but is extensively infiltrated with fat tissue (see p. 381).

Actually it is a paired organ, but the two glands come to lie with their medial surfaces in close apposition, so as to give the impression of an unpaired organ consisting of two lobes. Technically a *right* and a *left lobe,* separated completely by connective tissue by fat tissue in the adult, are recognized. It is a flat organ of a clear greyish-red colour and of rather soft consistency; its contours may be very irregular, since frequently more or less deep notches extend into the gland. The lobation of the gland is always well marked, the lobules being separated by strands of connective tissue. All the lobes, however, are connected by a fine central cord of gland tissue, the *central tract.*

The upper end of the organ is often drawn out into a slender prolongation and may then extend into the neck; below the gland becomes distinctly broader. Like the thyreoid gland it belongs to the category of ductless glands (glandulae clausae).

Fig. 464. A section through a portion of a human lung. ($^5/_1$)
Fig. 465. Front view of the thymus gland of a girl of fourteen years, with the neighboring mediastinal structures and the pleurae. ($^1/_2$) The anterior mediastinal pleura have been entirely removed, the pericardial pleurae partly; the anterior borders of the lungs are greatly retracted. The left gland is decidedly the larger and shows a short cervical portion.

greatly retracted. The left gland is decidedly the larger and shows a short cervical portion.

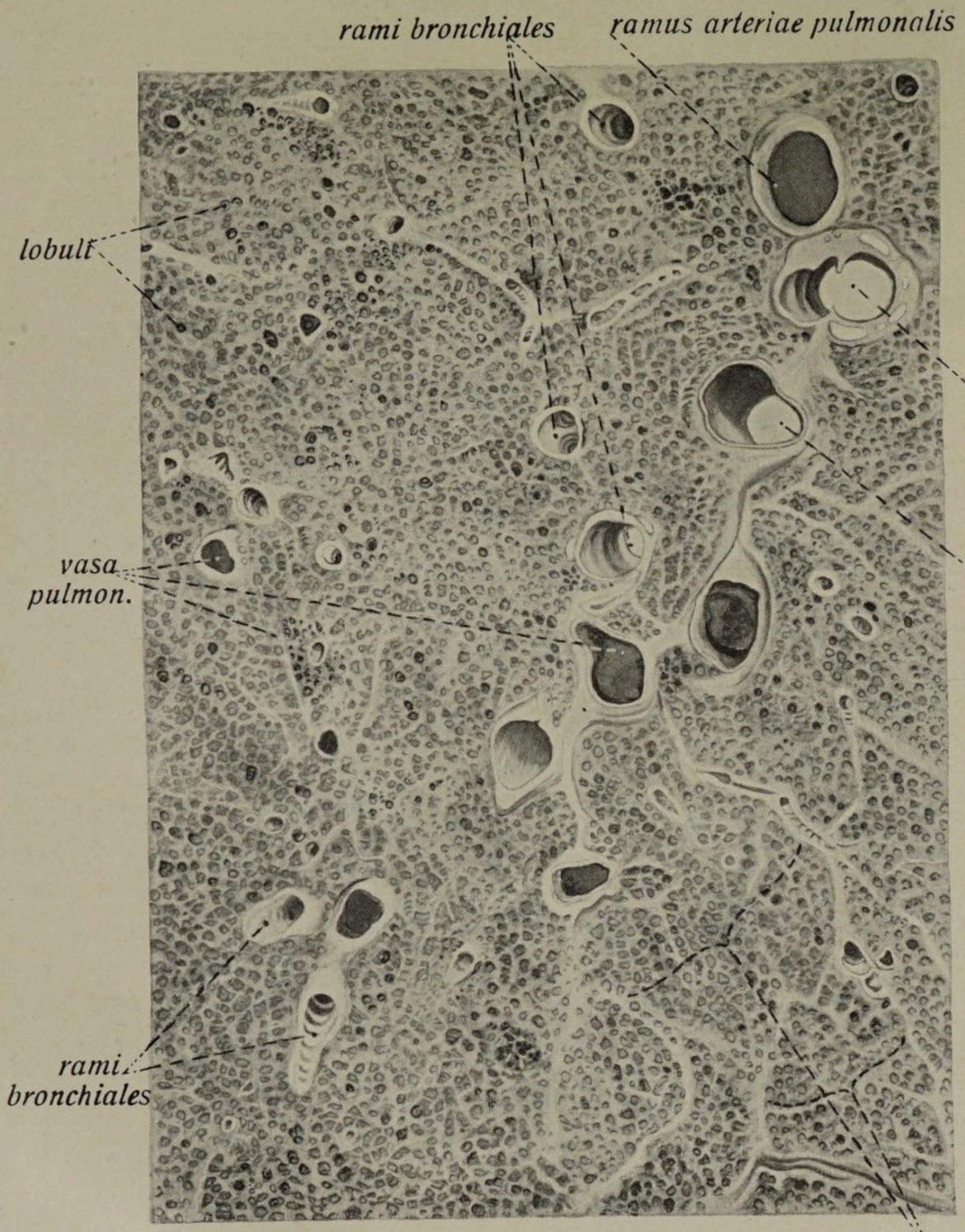


Fig. 464.

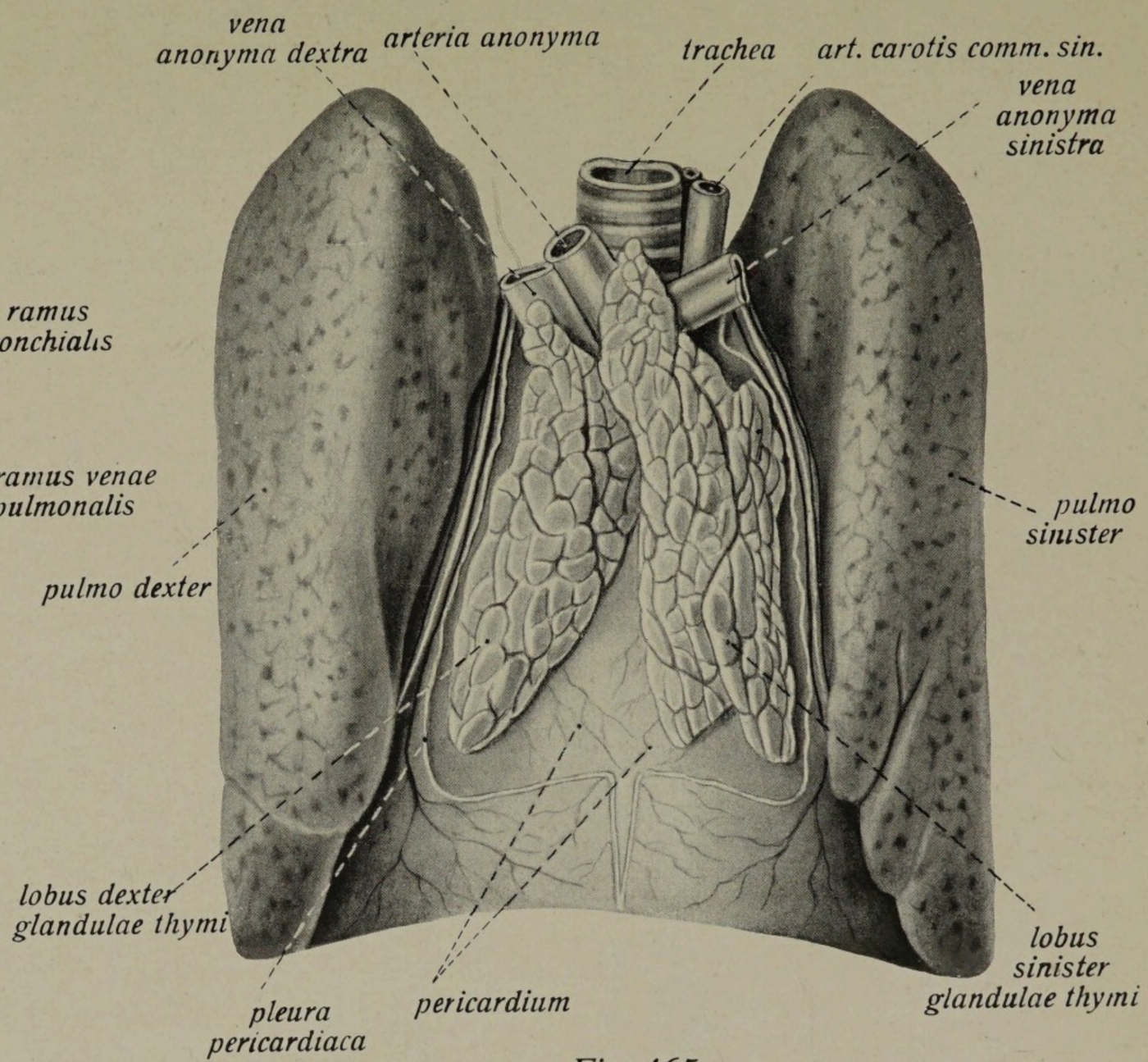


Fig. 465.

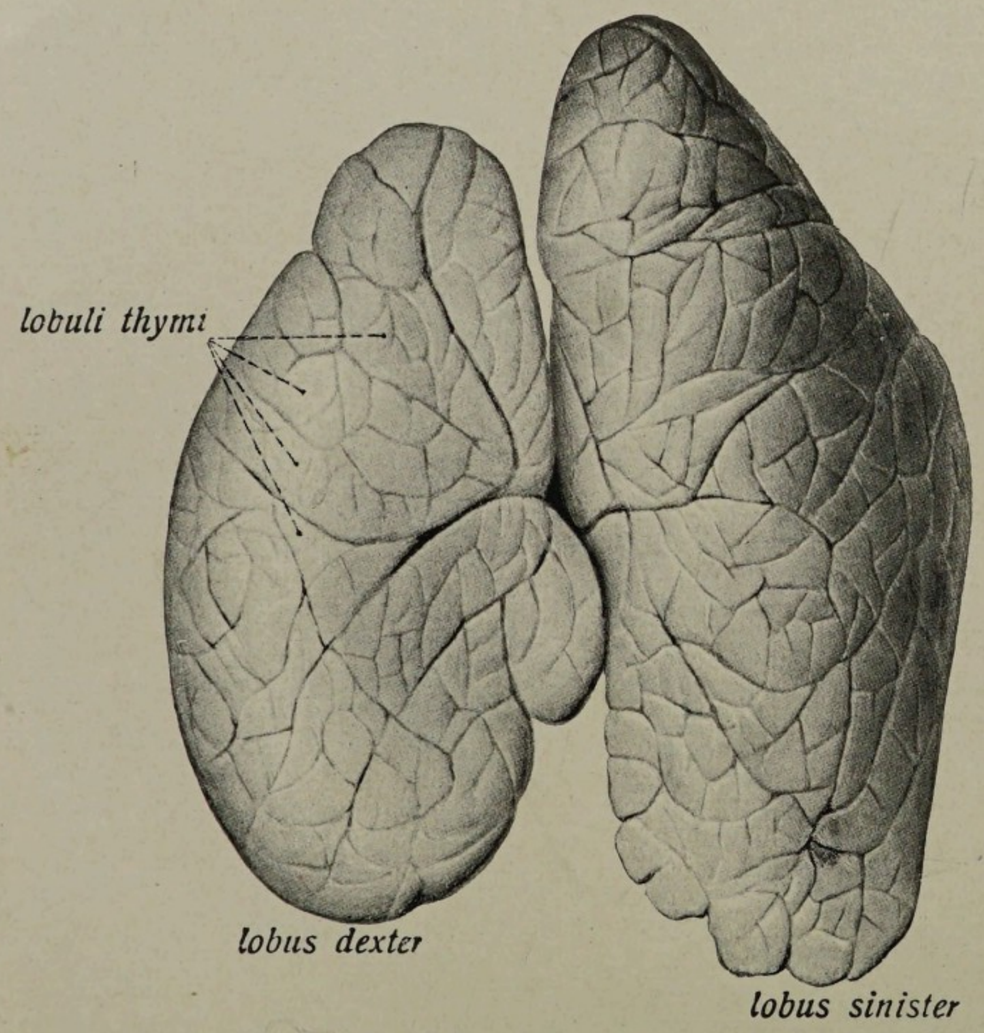


Fig. 466.

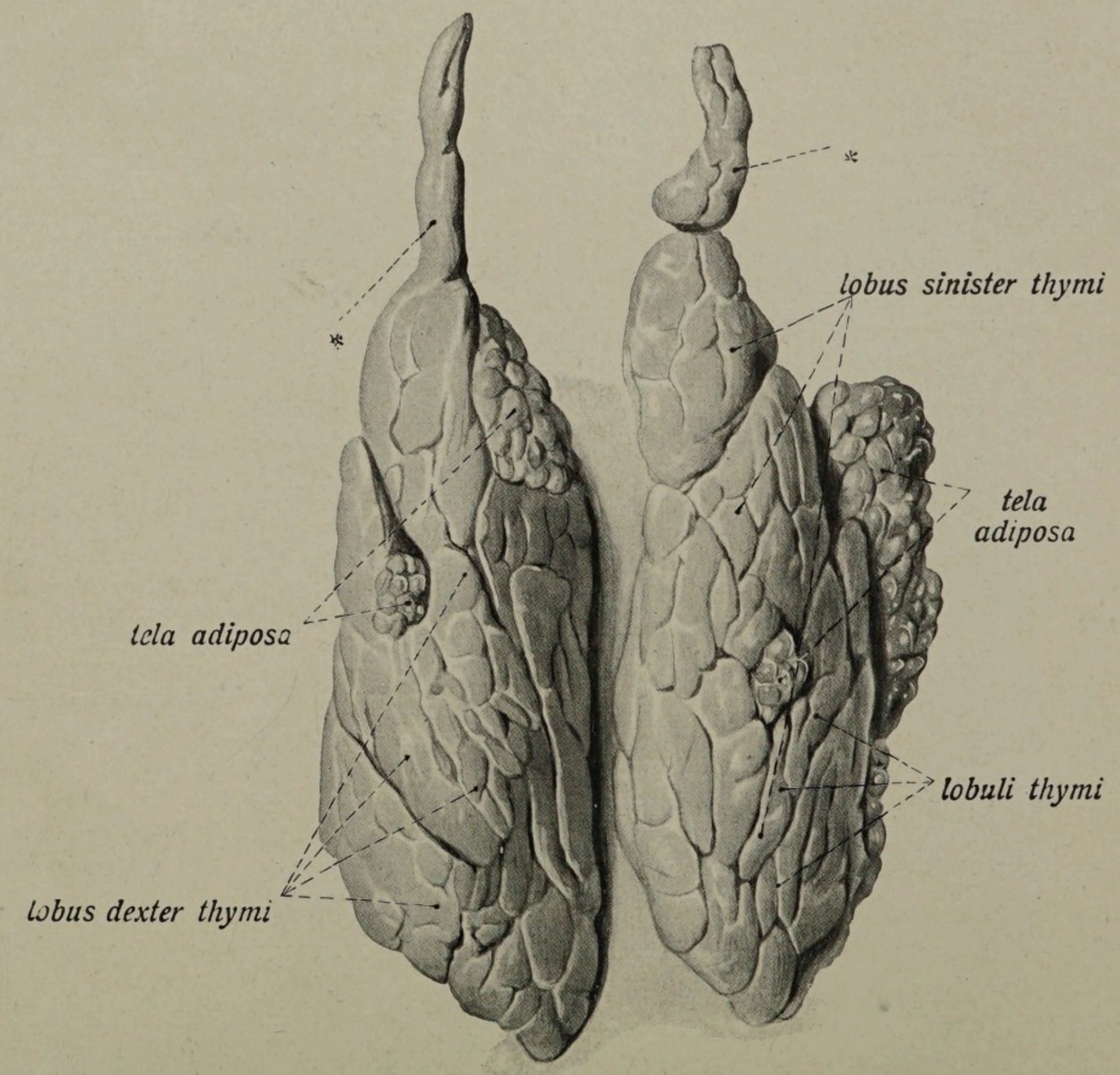


Fig. 467.

Fig. 466. The thymus of a two-year old child, from in front. (1/2)

The Respiratory Organs. Appendix: The Thymus. (Cont.)

The Thymus Gland.

The thymus is about twice as long as it is broad and it is flat up to its middle broadest portion. On the posterior surface it appears to be distinctly concave, lying as it does on the convex pericardium. It is situated in the upper portion of the superior mediastinum, behind the manubrium and upper portion of the body of the sternum; in childhood, however, it rests broadly on the anterior surface of the pericardium and extends into the anterior mediastinum. It also lies in front of the left innominate vein, between the vein on the one side and the manubrium and upper part of the body of the sternum on the other; it lies, accordingly, in front of the arch of the aorta and its great branches and between the two anterior mediastinal laminae, which rest upon the lateral surfaces of the organ. The upper, elongated ends of the thymus lobes often extend into the neck, even to the thyreoid gland.

The remains of the thymus in the adult, strongly infiltrated with fat, reaches neither by its upper nor its lower end the levels attained by the thymus of the child, which appears as a compact glandular mass often only to the twelfth year. At the most it reaches the apex of the pericardium, no longer, as in the child, extending upon its anterior surface, since in the adult the growth of the gland lags markedly behind that of the heart. It is consequently limited in the adult usually to the anterior portion of the superior mediastinum, where it lies imbedded in the so-called retrosternal fat body. Occasionally, however, even in the adult, the thymus forms a compact mass within the mediastinal fat tissue.

Fig. 466. The thymus of a two-year old child, from in front. (1/2)
Fig. 467. The thymus of a man of 24 years after removal of the surrounding fat. * = continuation of the gland into the neck. (1/1)

The Position of the Thoracic Viscera.

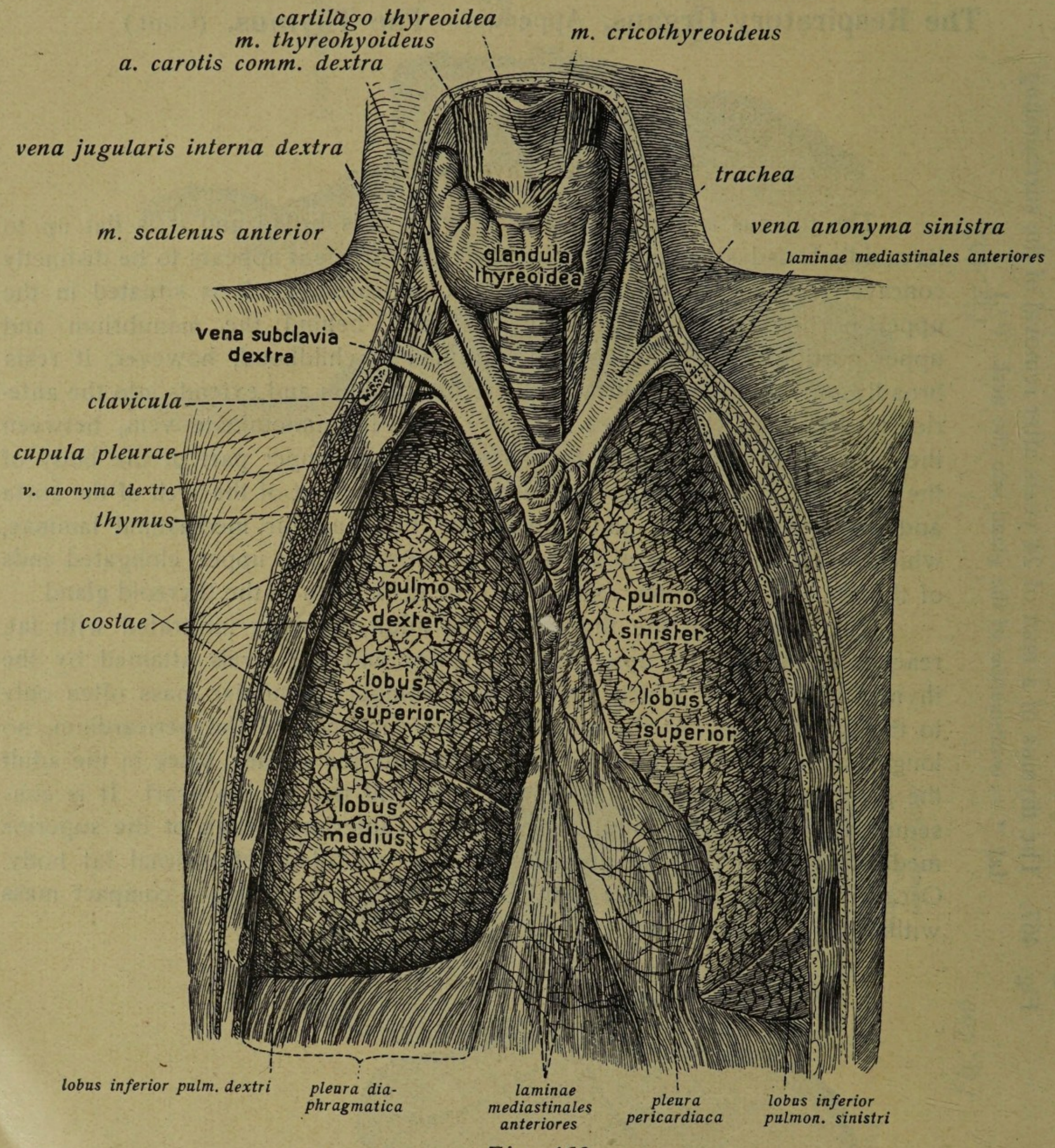


Fig. 468.

Figs. 468 and 469. The position of the thoracic organs of an eight year old boy. From in front. (1/2) The thoracic wall has been removed back to near the mamillary line by cutting the ribs, etc. The pleural cavities are opened by the removal of the portion of the costal pleura corresponding to the portion of the costal wall that was removed. Above the thymus gland the large vessels and the trachea are exposed.

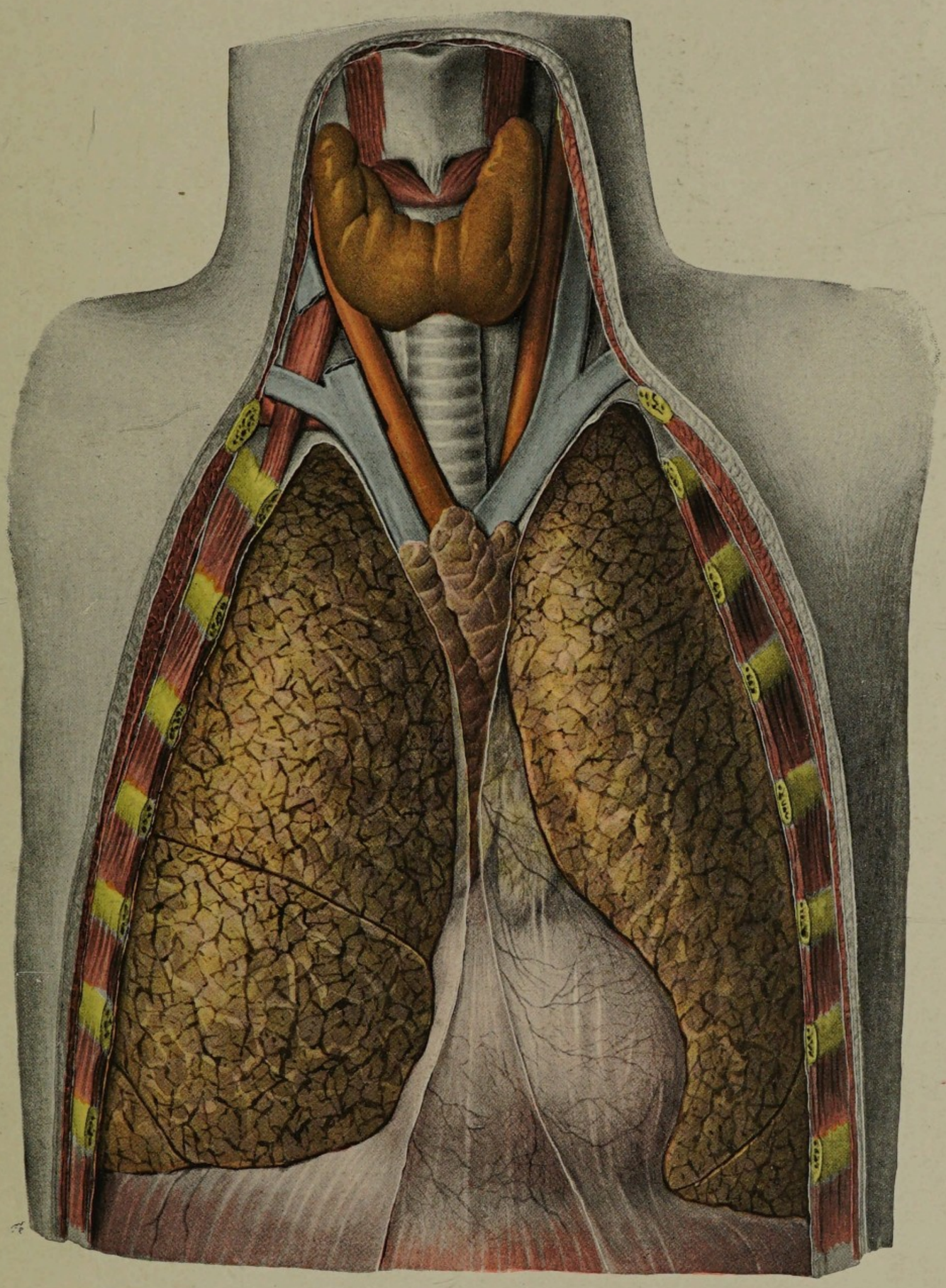


Fig. 469.

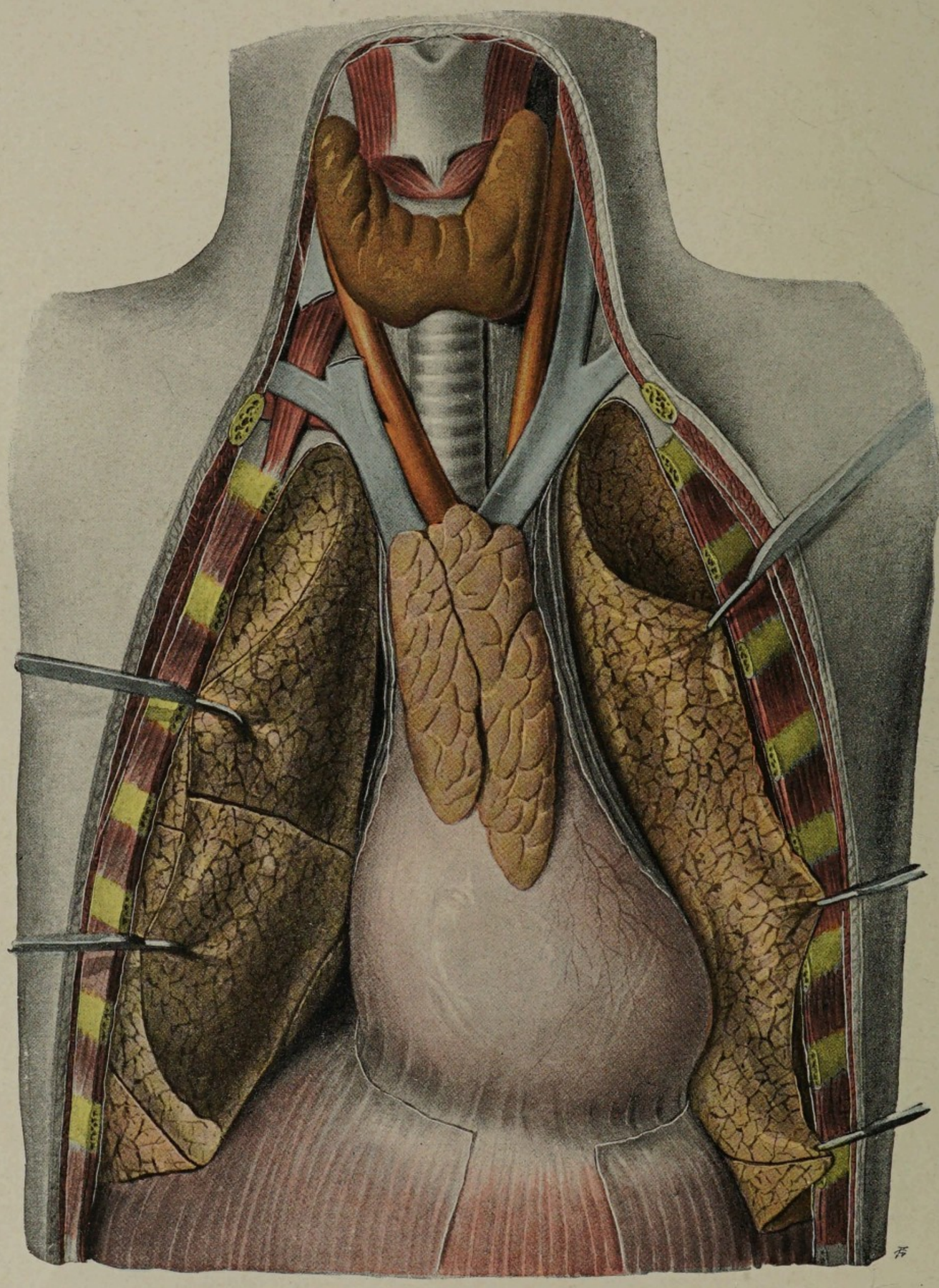


Fig. 470.

The Position of the Thoracic Viscera.

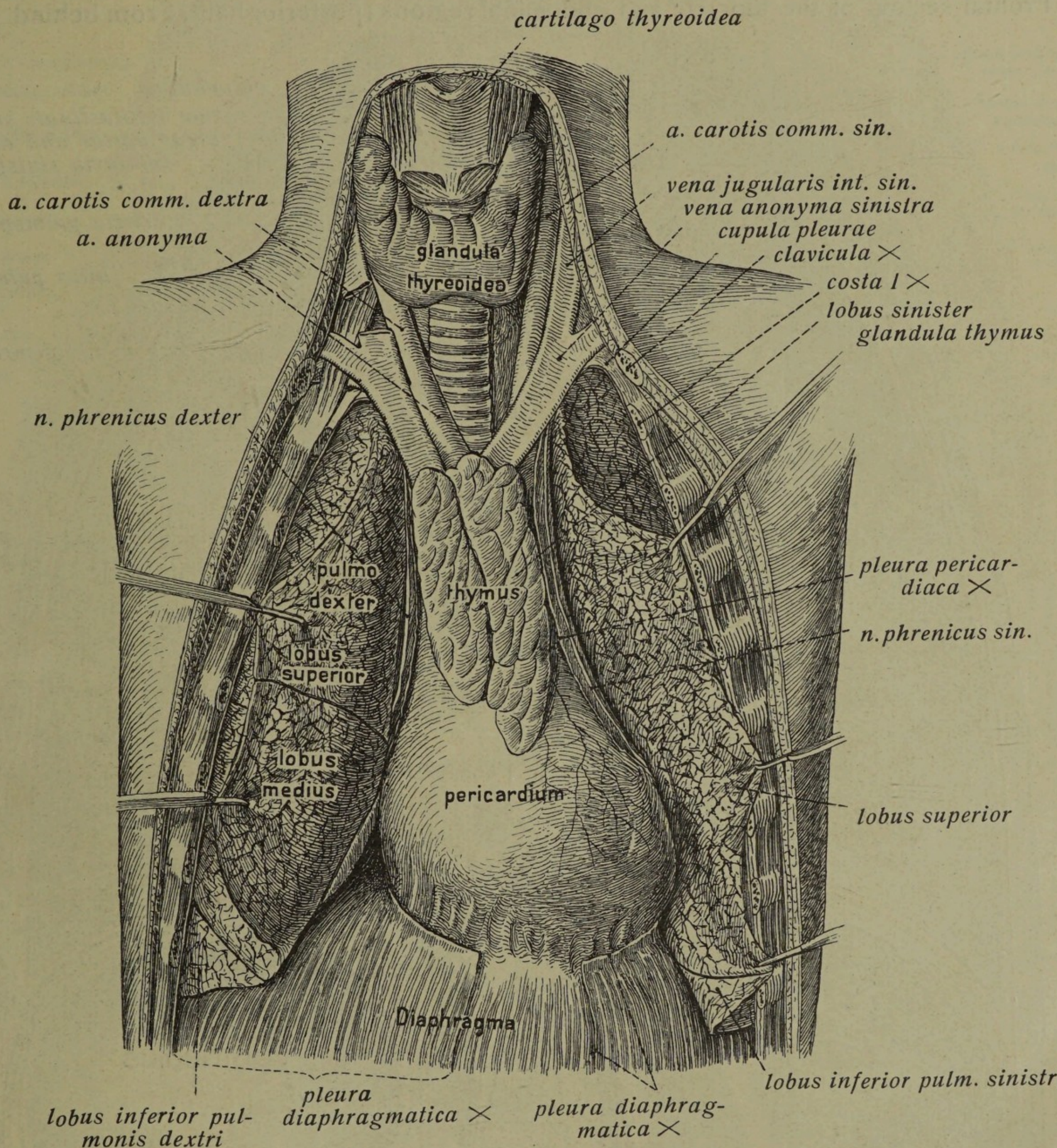


Fig. 471.

Figs. 470 and 471. The position of the thoracic organs of an eight year old boy. From in front. (1/2) The preparation is similar to that of Fig. 468—469, except that the pericardial pleurae have for the most part been removed, so as to expose the pericardium and thymus gland. With the same object the anterior borders of the lungs have been drawn back.

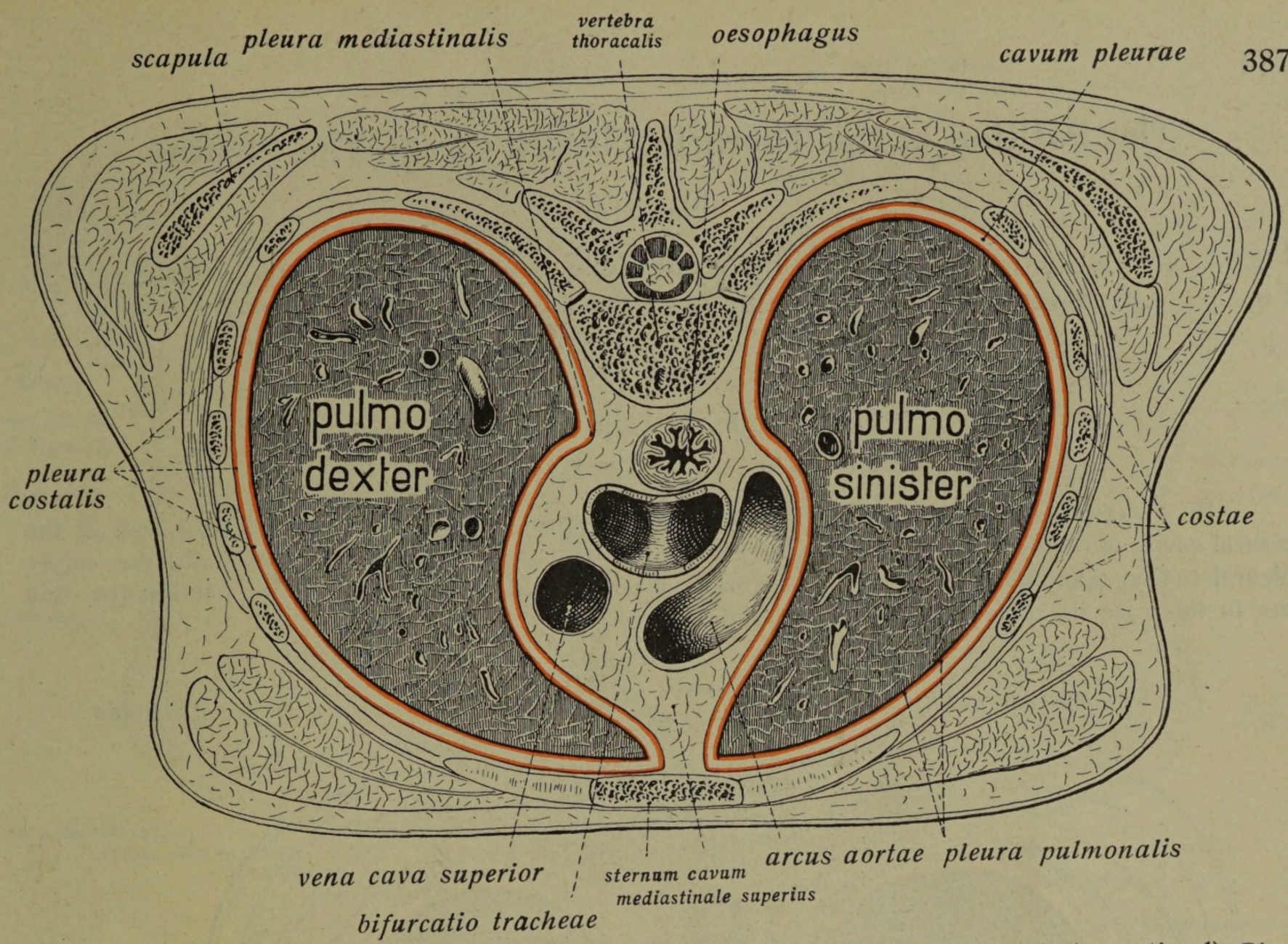


Fig. 473. The relations of the pleurae above the heart. Transverse section (schematized). Pleura red.

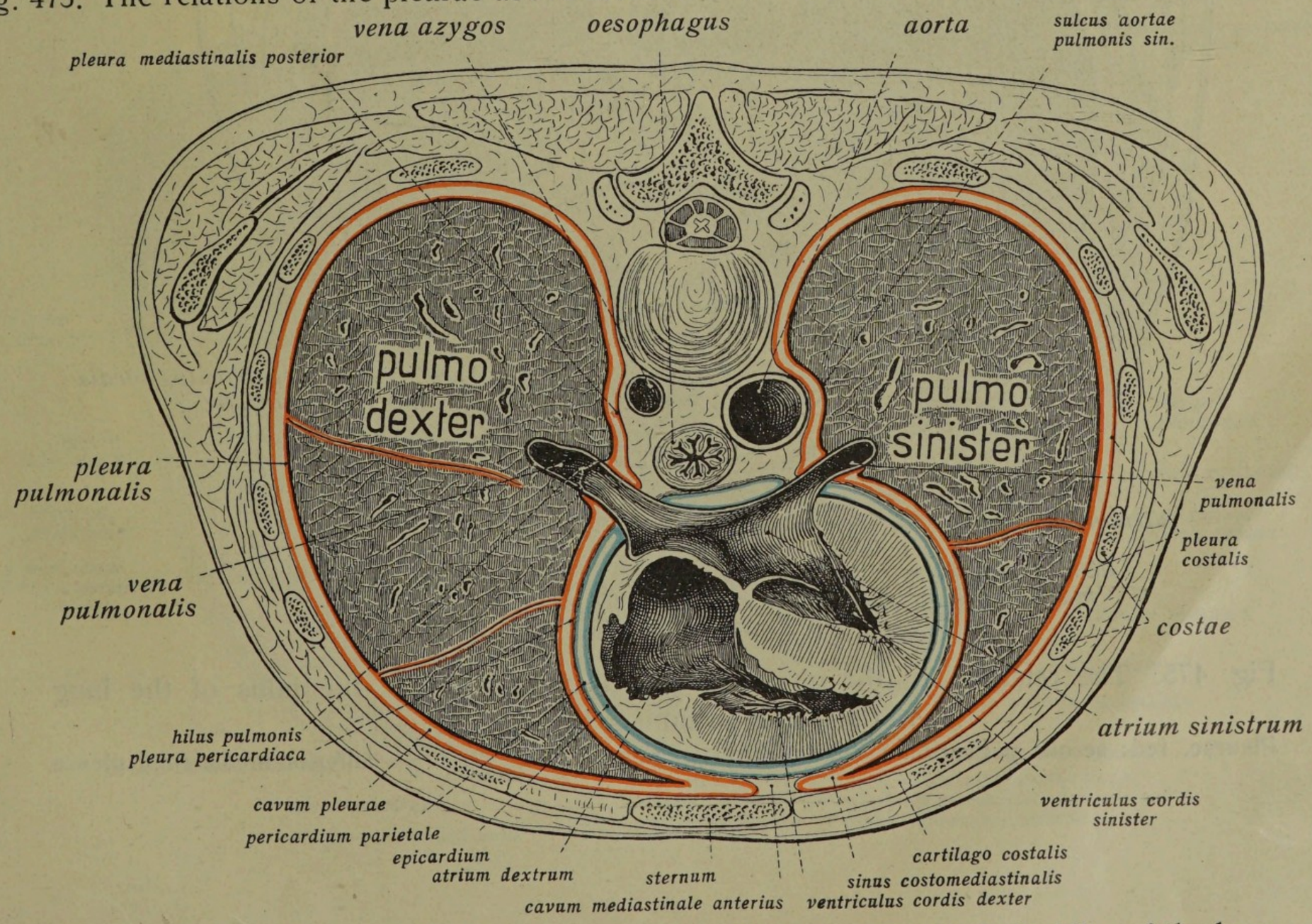


Fig. 474. The relations of the pleurae and pericardium at the level of the hilus of the lung. Transverse section (schematized). Pleura, red: serous pericardium, blue: fibrous pericardium, black.

The Position of the Thoracic Viscera (Cont.), The Pleurae.

Plate 14.

Fig. 1. A transverse section of the thorax at the level of the fourth thoracic vertebra. ($^2/_5$)
Fig. 2. A transverse section of the thorax at the level of the nipples. ($^2/_5$)

Plate 15.

Fig. 1. The left pleural cavity of a child. ($^3/_4$)
Fig. 2. The right pleural cavity of a child. ($^3/_4$)

By a sagittal section the ribs and clavicle are cut through and thereby the lateral wall of the pleural cavity is removed. The lung has been cut out close to the hilus. One looks into the empty pleural cavity, upon the parietal pleura covering all the walls of the cavity. The hemiazygos vein has in this case its principal outflow in a supreme intercostal vein.

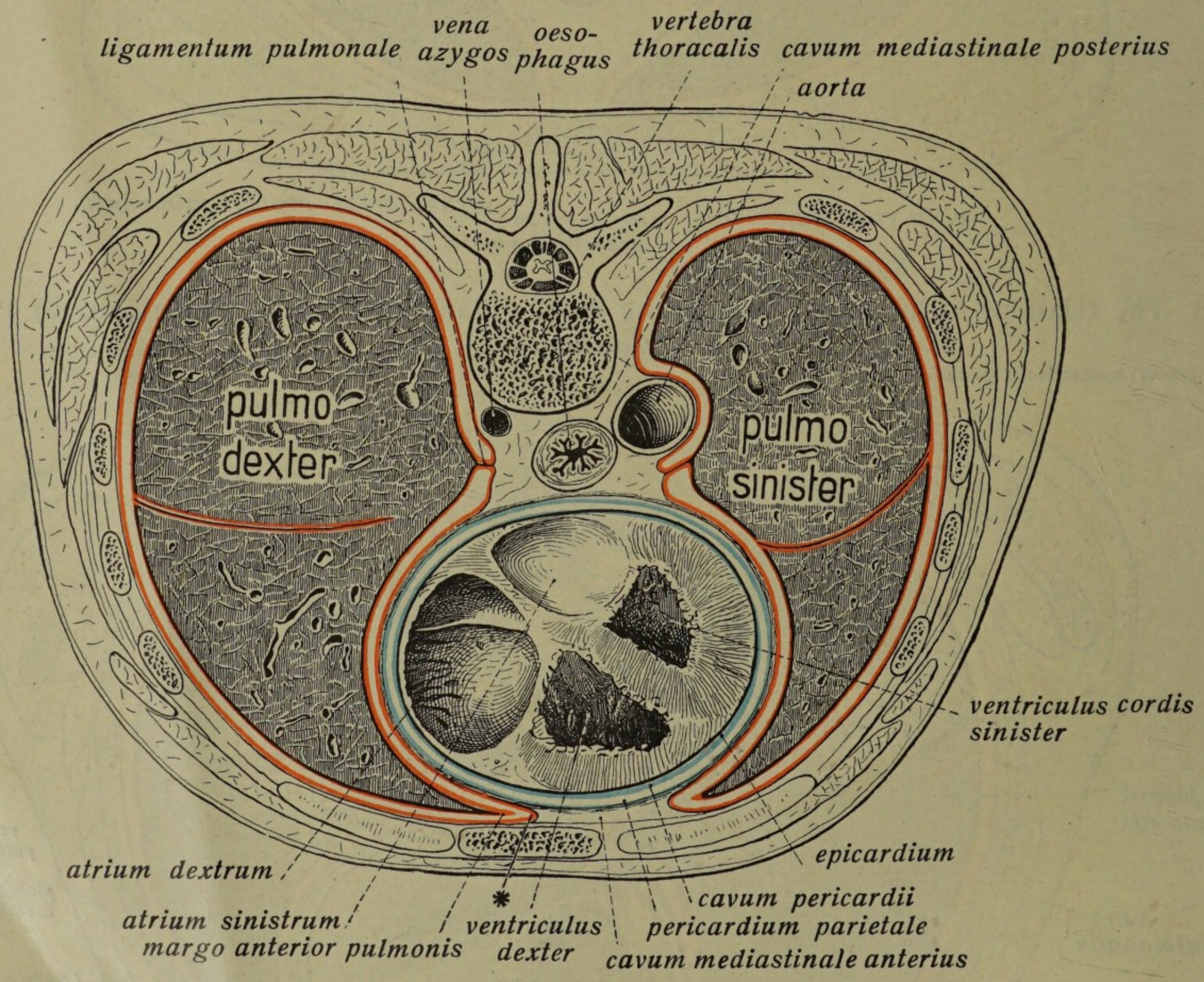


Fig. 475. The relations of the pleurae and pericardium below the hilus of the lung. Transverse section (schematized).
Pleurae, red: serous pericardium, blue; fibrous pericardium, black. * = anterior mediastinal pleura.

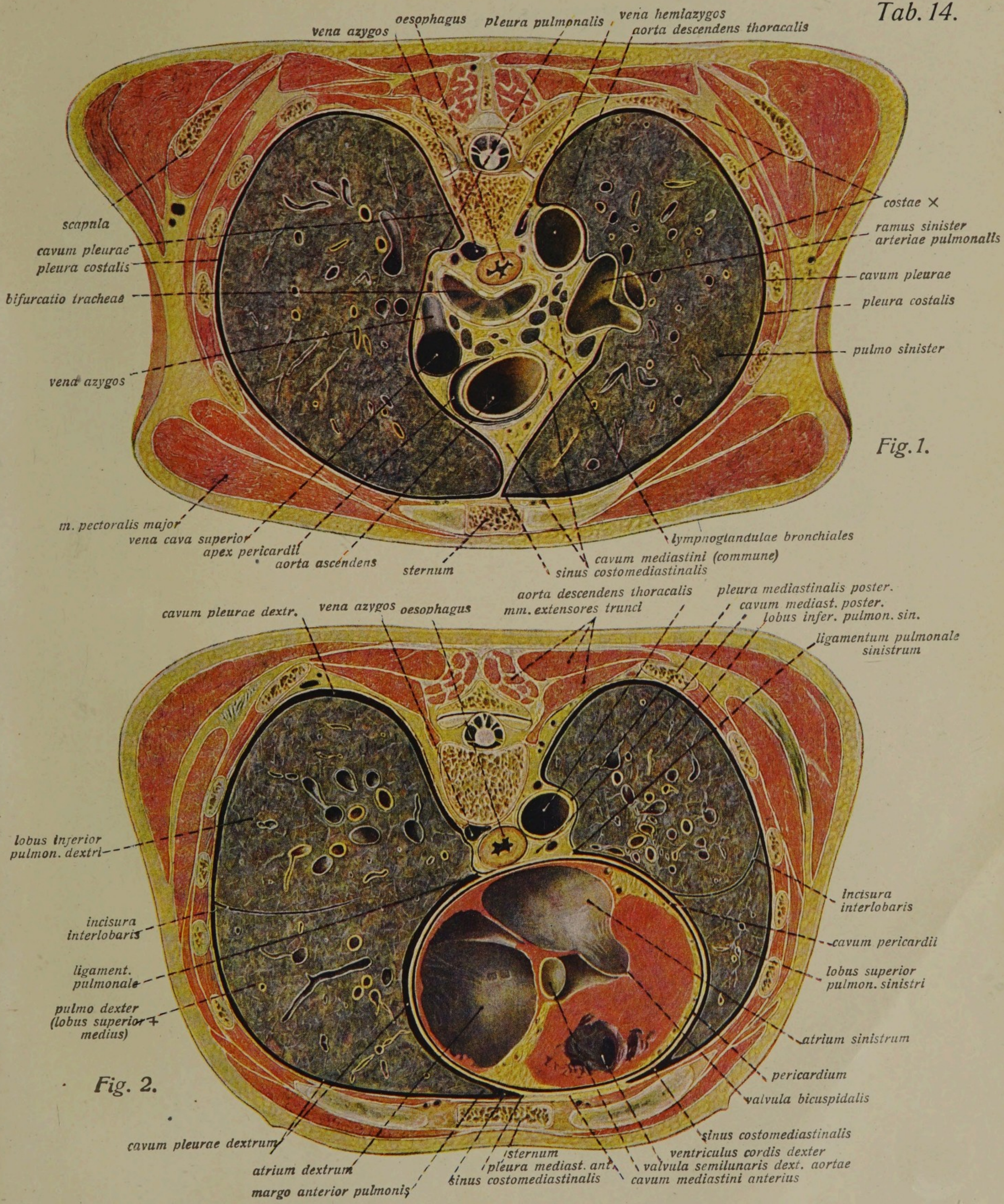

vena azygos
oesophagus
pleura pulmonalis
vena hemiazygos
aorta descendens thoracalis
scapula
cavum pleurae
pleura costalis
bifurcatio tracheae
vena azygos
costae X
ramus sinister arteriae pulmonalis
cavum pleurae
pleura costalis
pulmo sinister
m. pectoralis major
vena cava superior
apex pericardii
aorta ascendens
sternum
lympnoglandulae bronchiales
cavum mediastini (commune)
sinus costomediastinalis

Fig. 1.

cavum pleurae dextr.
vena azygos
oesophagus
aorta descendens thoracalis
mm. extensores trunci
pleura mediastinalis poster.
cavum mediast. poster.
lobus infer. pulmon. sin.
ligamentum pulmonale sinistrum
lobus inferior pulmon. dextri
incisura interlobaris
ligament. pulmonale
pulmo dexter (lobus superior + medius)
incisura interlobaris
cavum pericardii
lobus superior pulmon. sinistri
atrium sinistrum
pericardium
valvula bicuspidalis
sinus costomediastinalis
ventriculus cordis dexter
valvula semilunaris dext. aortae
cavum mediastini anterius
cavum pleurae dextrum
atrium dextrum
margo anterior pulmonis
sternum
pleura mediast. ant.
sinus costomediastinalis

Fig. 2.

art. subclavia

sympathicus

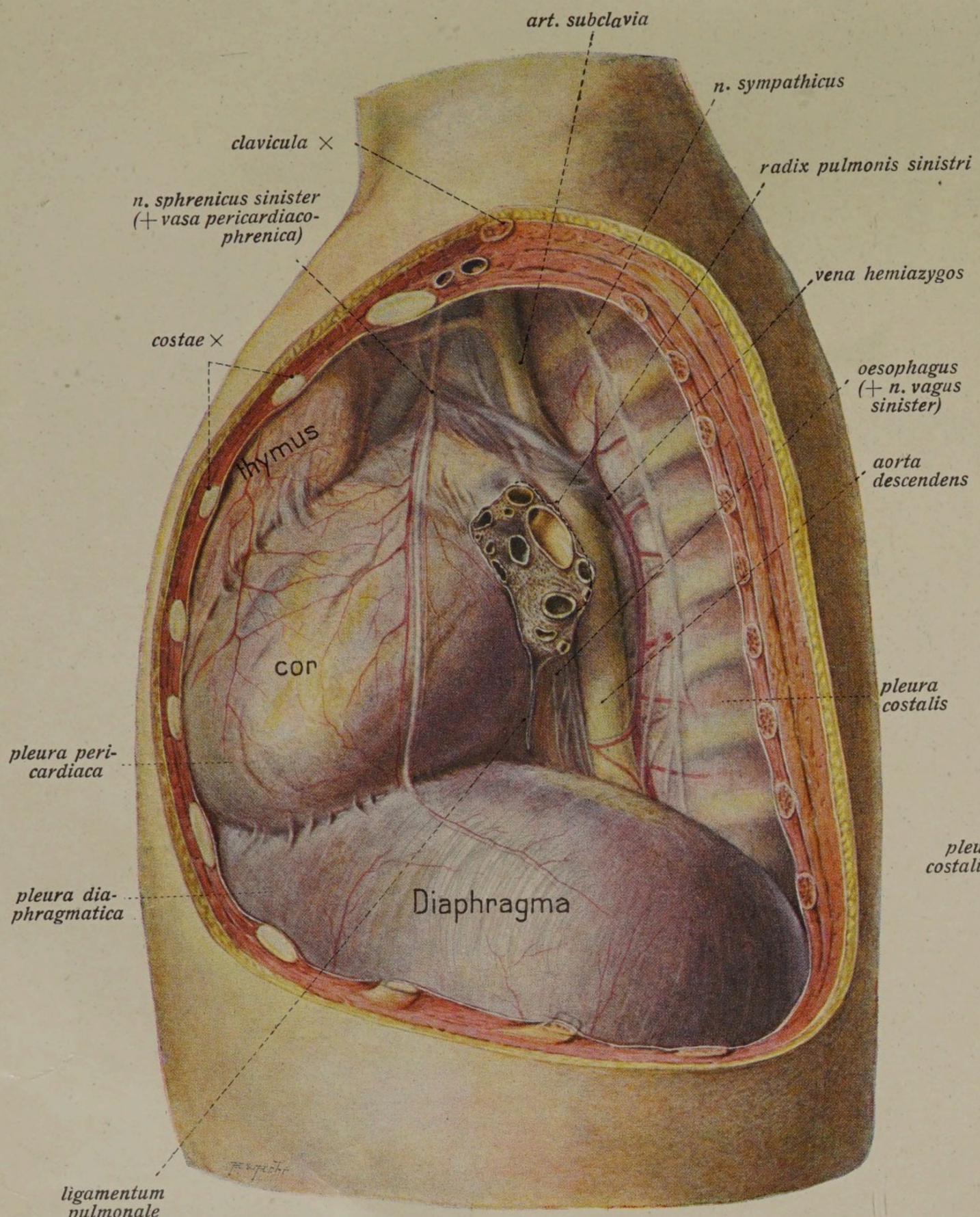


Fig. 1.

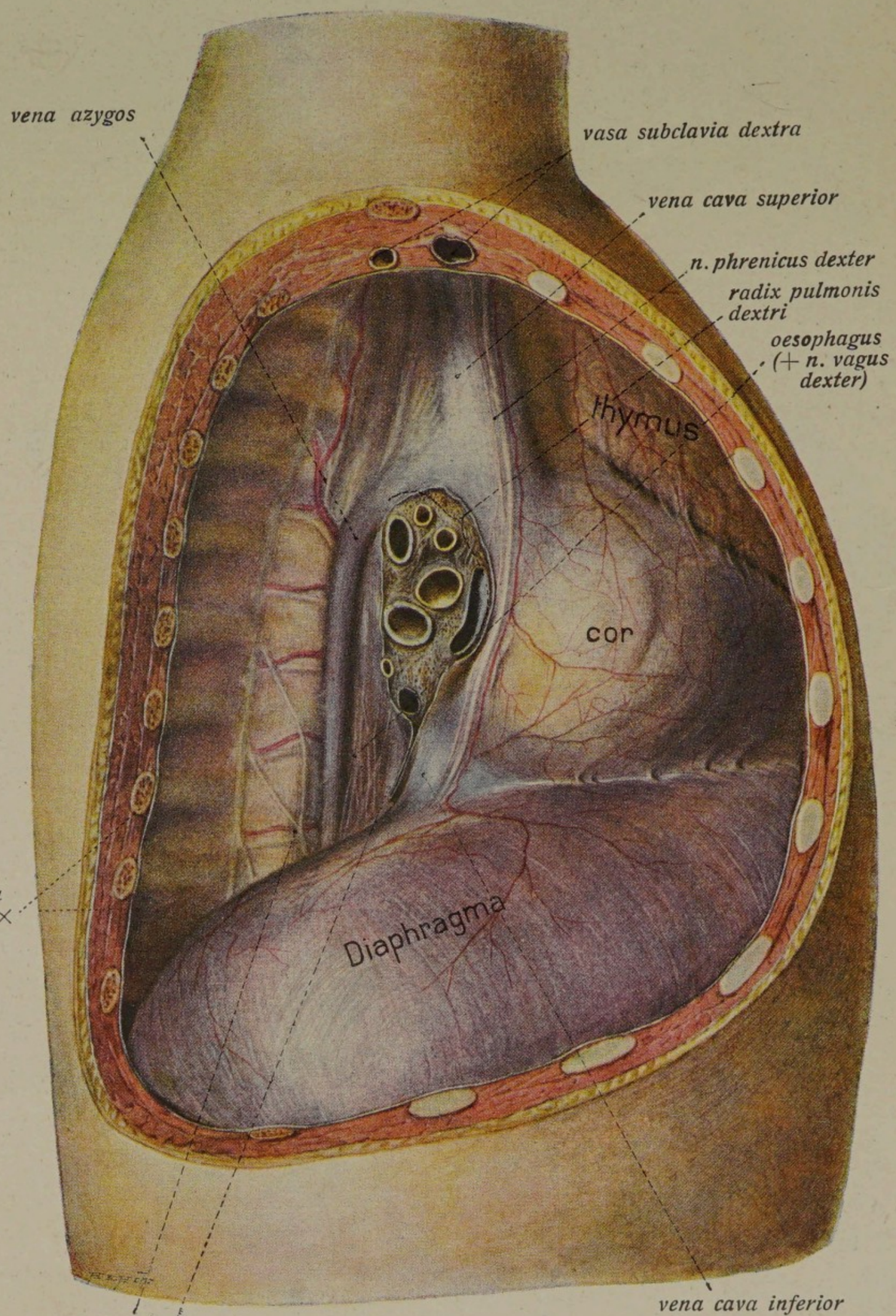


Fig. 2.

Tab. 15.

The Urogenital Organs.

apparatus urogenitalis.

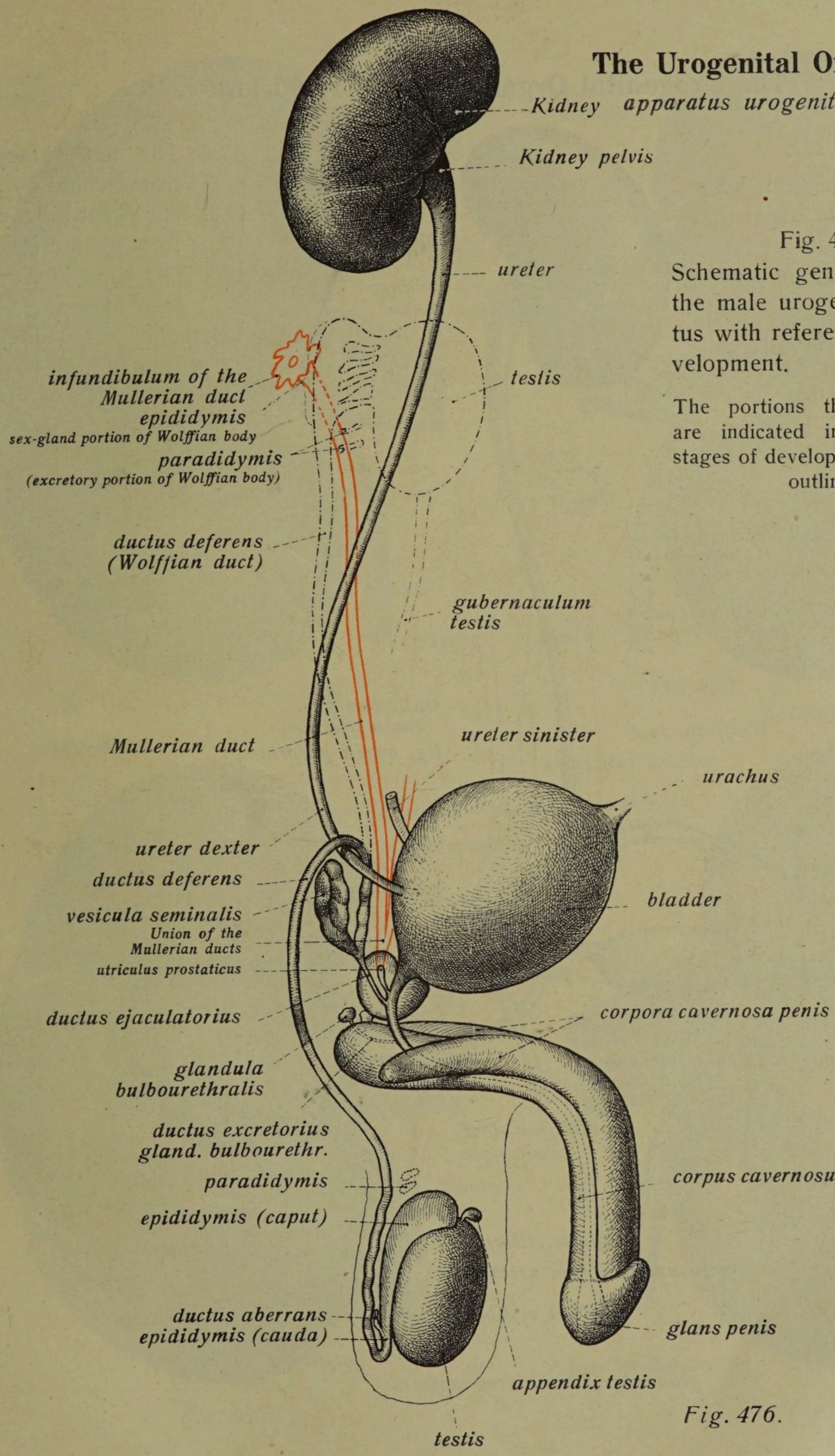


Fig. 476.

Schematic general view of the male urogenital apparatus with reference to its development.

The portions that degenerate are indicated in red; earlier stages of development by dotted outlines.

Fig. 476.

The Urogenital Organs (Cont.). The Kidney.

Fig. 477.

Schematic general view of the female urogenital apparatus, with reference to its development.

The portions that degenerate are indicated in red; positions occupied before the descent by dotted outlines.

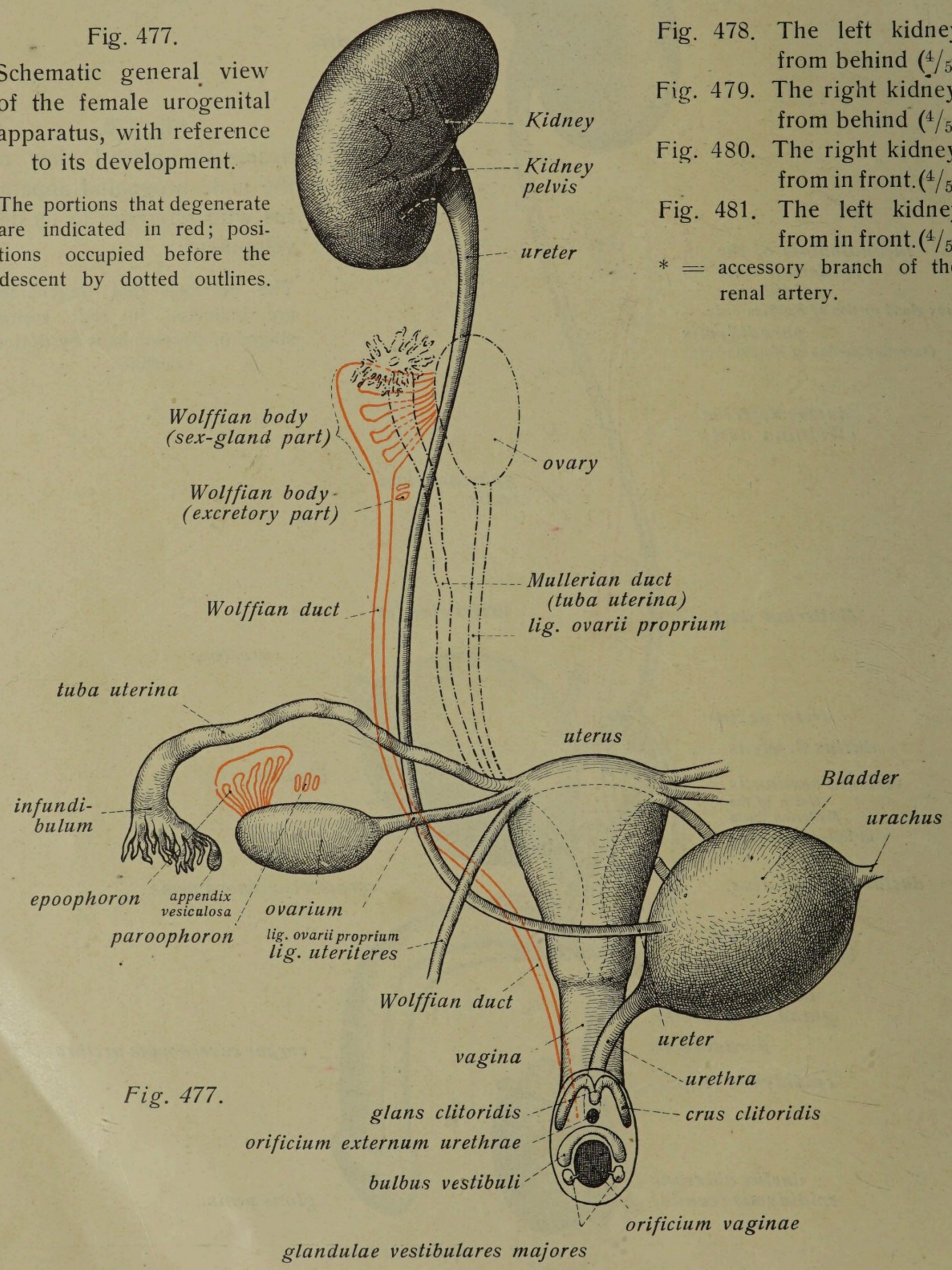


Fig. 477.

Fig. 478. The left kidney from behind ($^4/_5$)

Fig. 479. The right kidney from behind ($^4/_5$)

Fig. 480. The right kidney from in front. ($^4/_5$)

Fig. 481. The left kidney from in front. ($^4/_5$)

* = accessory branch of the renal artery.

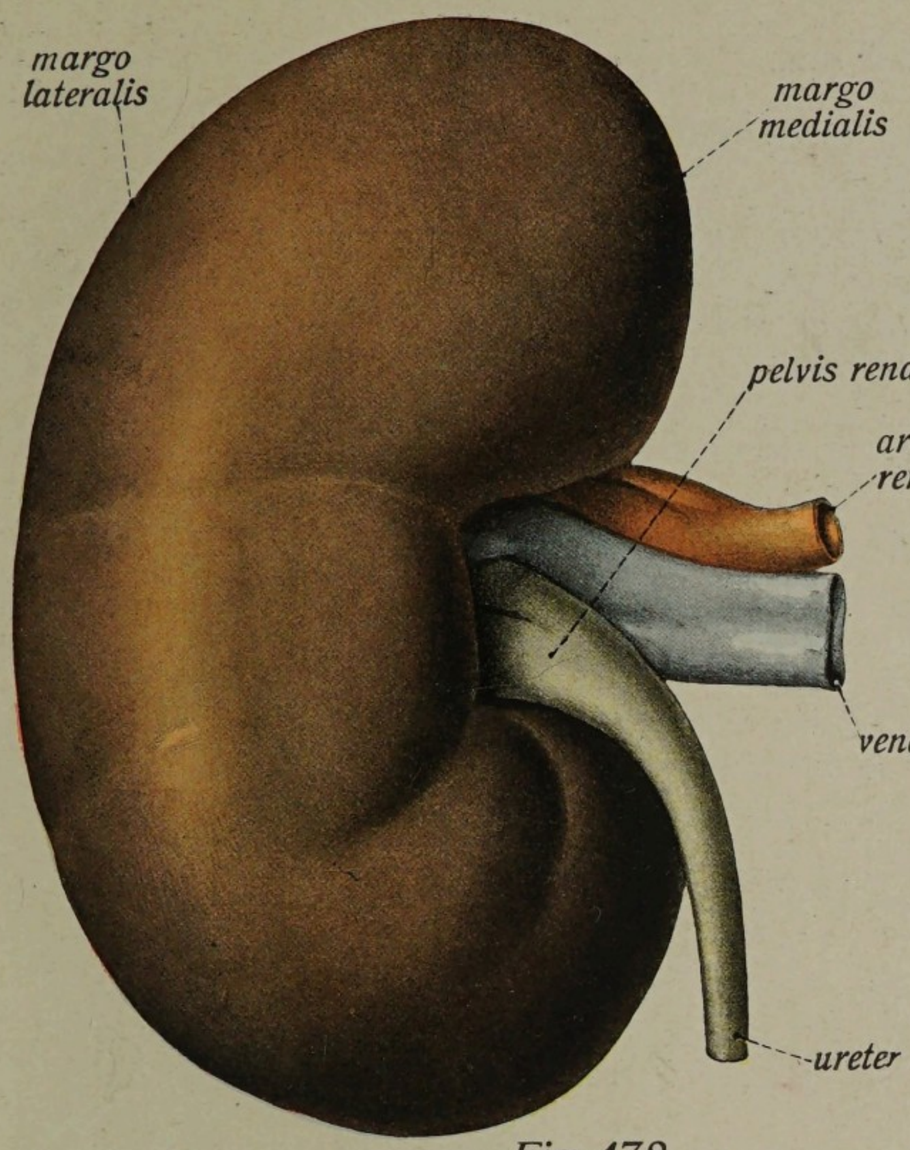


Fig. 478.

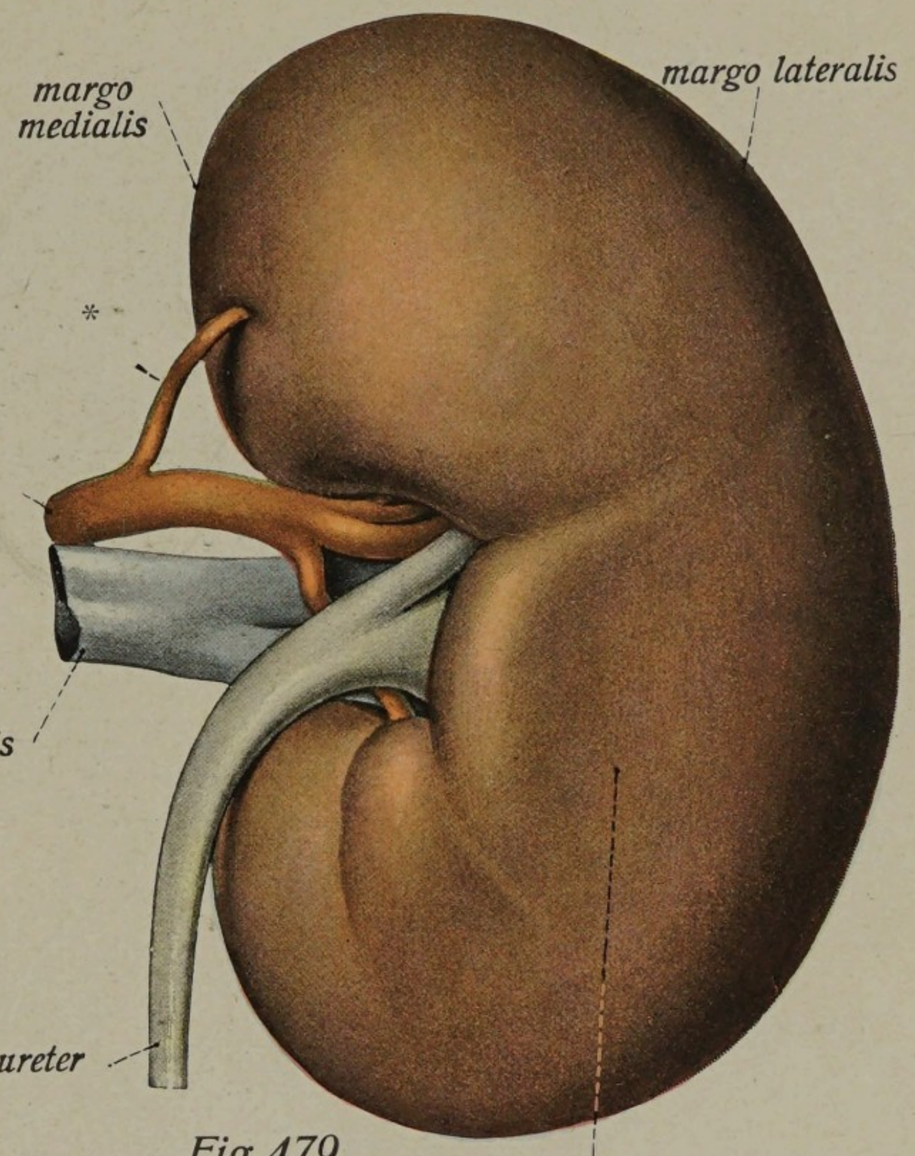


Fig. 479.

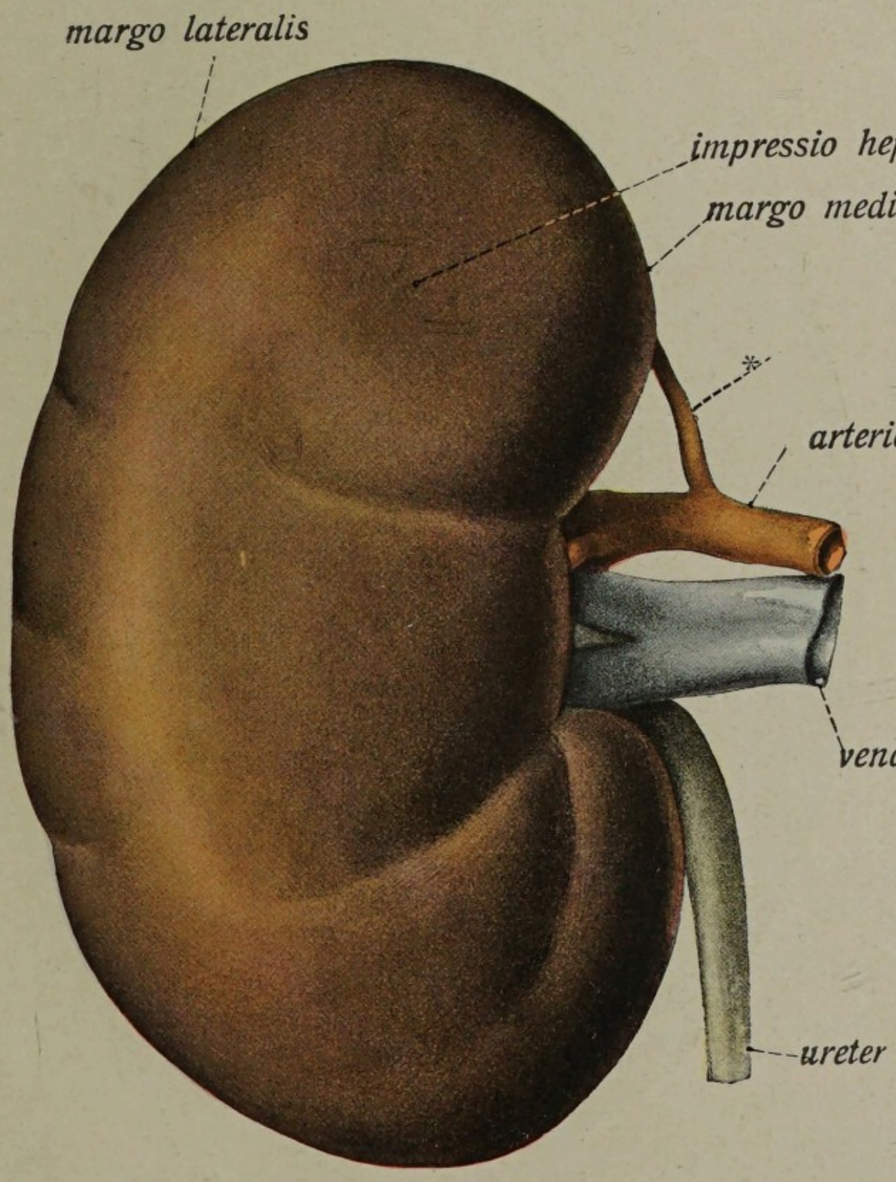


Fig. 480.

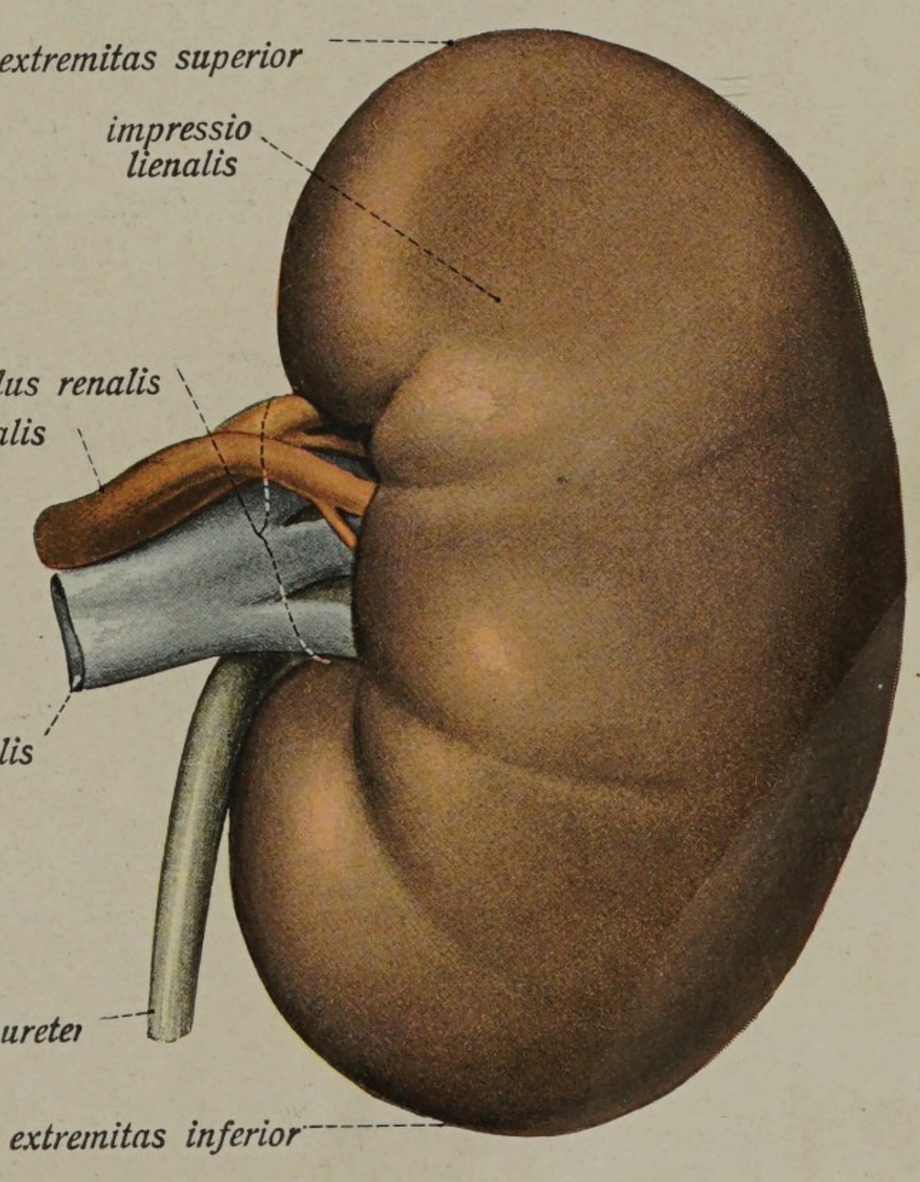


Fig. 481.

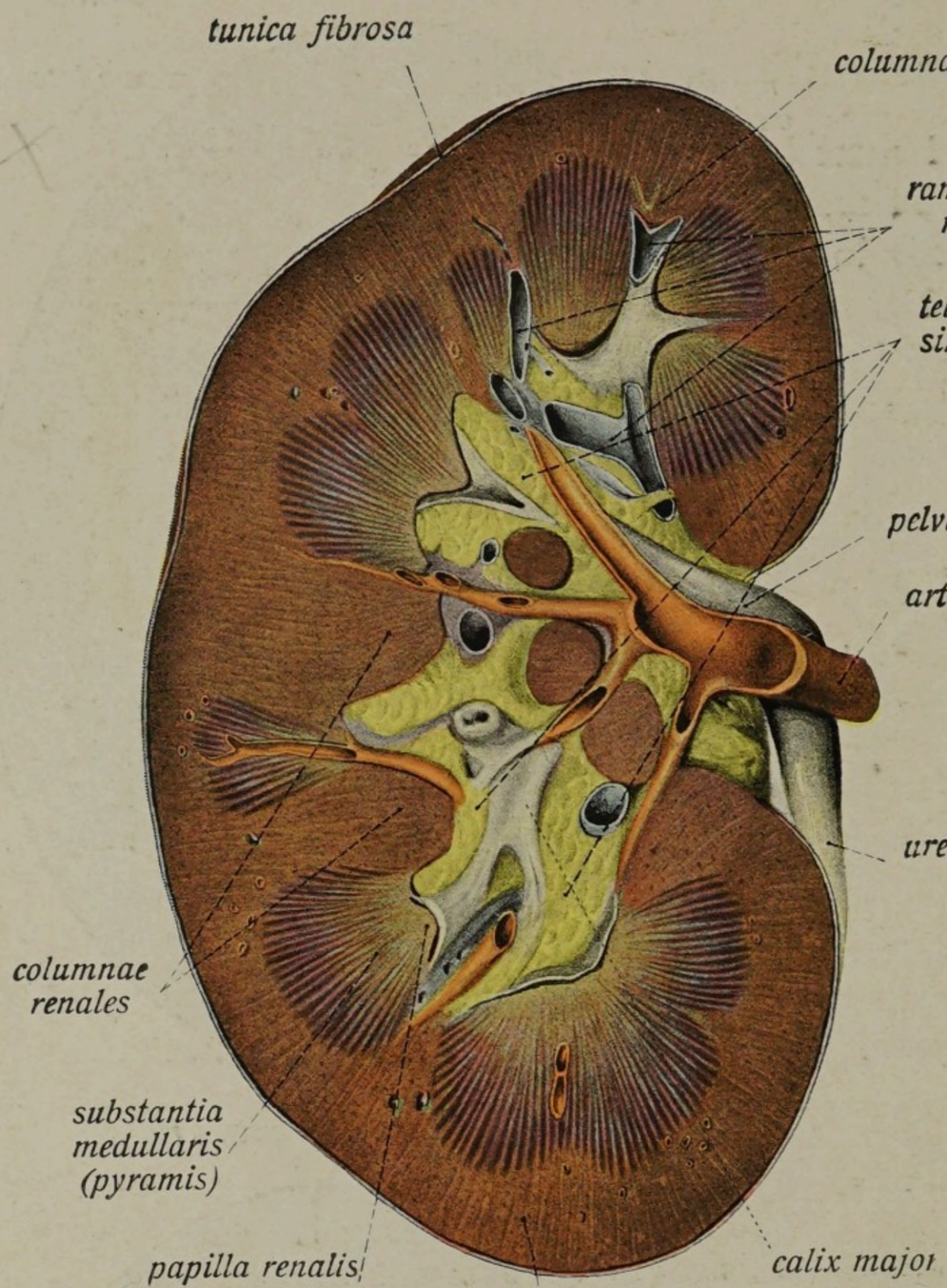


Fig. 482.

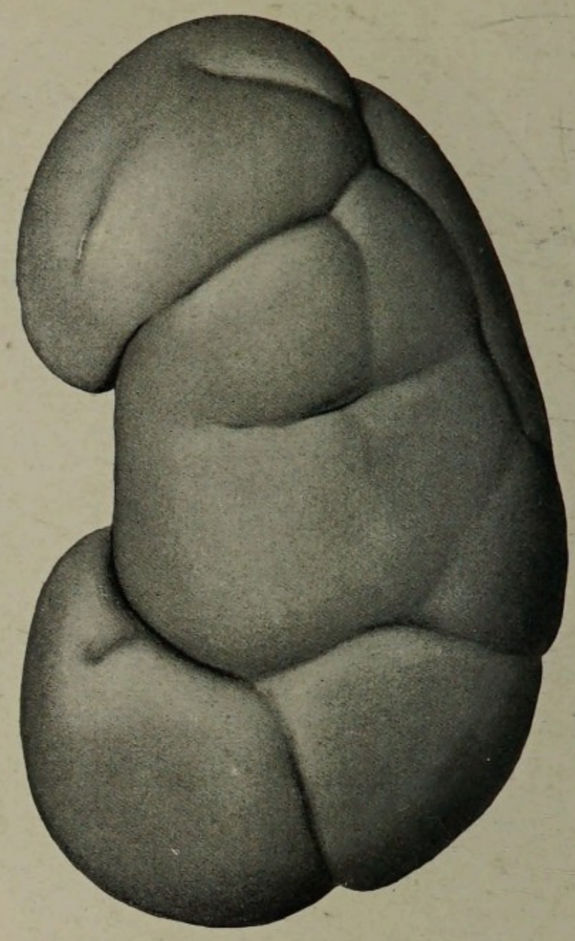


Fig. 483.

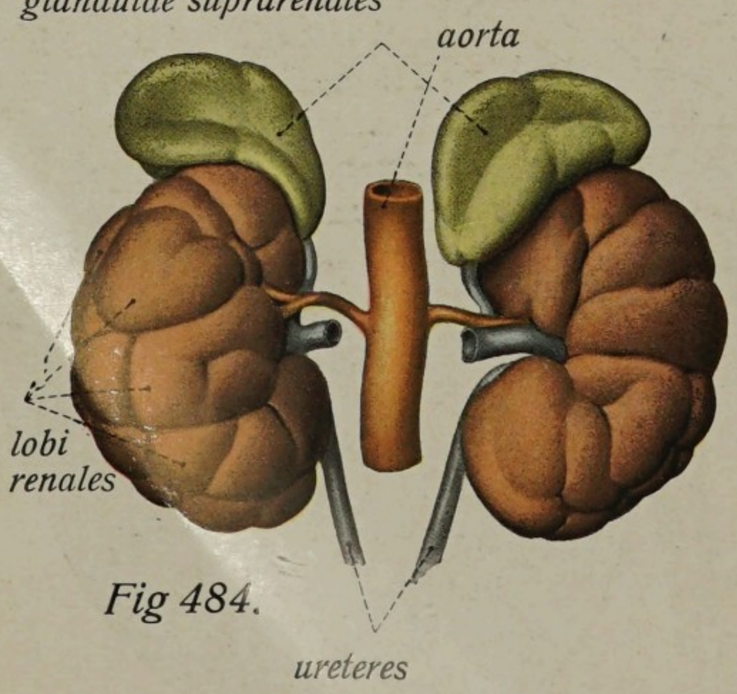


Fig 484.

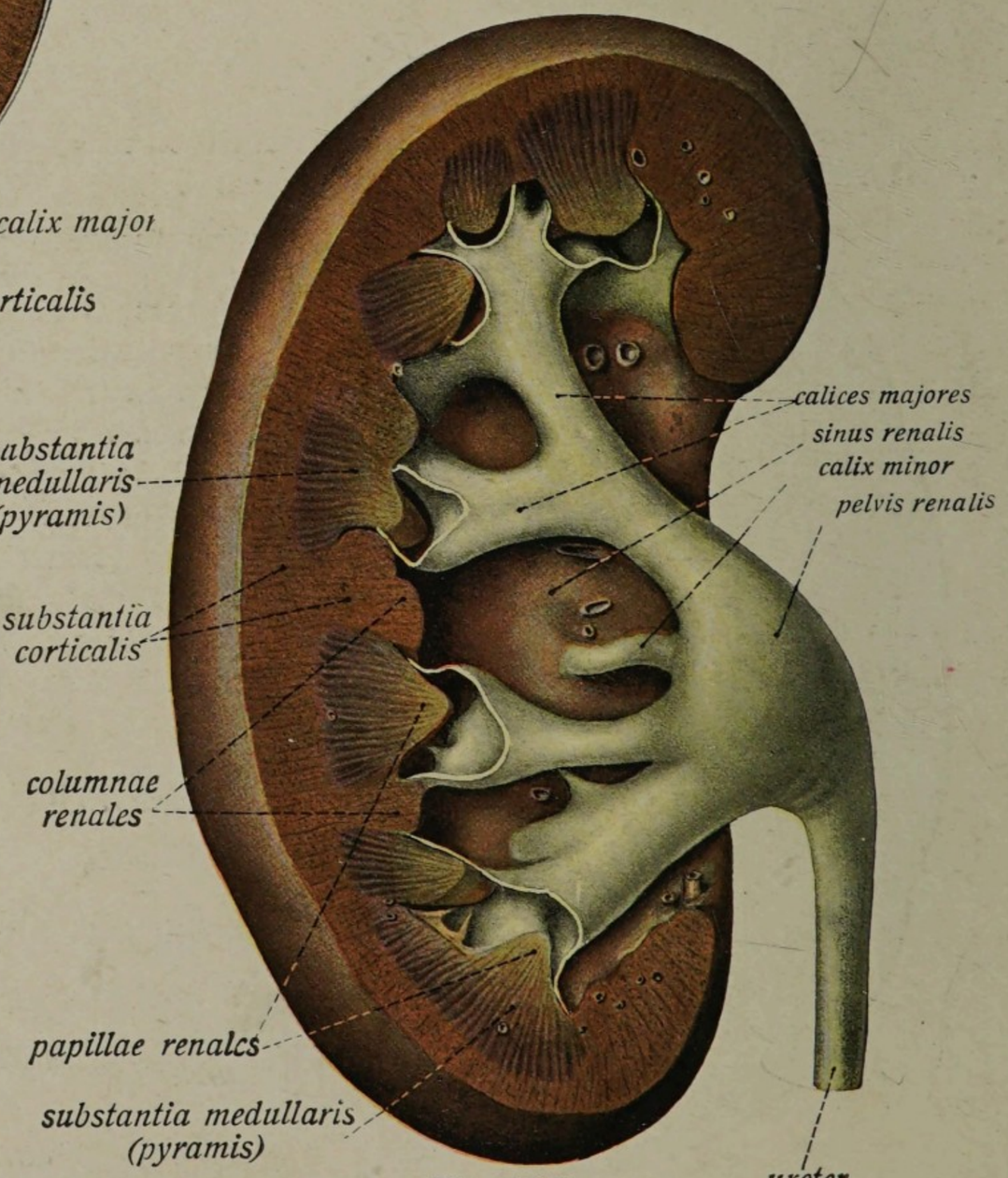


Fig. 485.

The Urogenital Organs. The Kidney. (Cont.)

Fig. 482. A frontal section through the kidney and its capsule. ($^1/_1$)
Fig. 483. The kidney of a child, distinctly lobed. ($^1/_1$)
Fig. 484. The kidney and suprarenal gland of an old fetus. ($^1/_1$)
Fig. 485. The renal sinus and pelvis exposed by a frontal section. ($^1/_1$)
The vessels and the fat tissue of the sinus are removed.

The Kidney, *renes*.

The *kidneys (renes)* are two paired organs resting on the posterior abdominal wall. Each has a strongly convex *anterior* and *posterior surface*, separated by rounded *medial* and *lateral* borders, the latter being convex, while the former at its middle is concave to form the *hilus*. The rounded ends are superior and inferior. The surfaces of the kidneys show faint impressions of the neighboring organs, a *muscular impression* on the posterior surface for the Quadratus lumborum and the *hepatic impression* on the anterior surface, the left kidney having also *gastric*, *pancreatic*, *colic* and *splenic (lienal) impressions*.

The hilus serves for the entrance of vessels and of the *ureter*, the latter being below and behind the vessels, and of these the artery is behind the vein. The hilus leads into a cavity, the *renal sinus*, surrounded by kidney substance. It has the form of the kidney and contains much fat tissue, the branches and the roots of the ureter, the *calices* and *pelvis*. The kidney is covered on its outer surface by a *fibrous tunic* or capsule and its substance consists of two portions, a *cortical* and a *medullary substance*. The former constitutes the whole of the surface of the kidney, while the medullary substance is formed by the *renal pyramids*, whose bases connect with the cortical substance, while their apices project as the *renal papillae* into the renal sinus. The papillae are 7—12 in number, the pyramids 15—20. At the apex of each papilla the straight urinary canals, the *ductus papillares*, open by minute *foramina papillaria (area cribrosa)*. Between the bases of the renal papillae portions of the cortical substance, the *renal columns* (Bertini), descend to the sinus and between them and the pyramids the stronger branches of the blood vessels enter or leave the kidney substance. The kidneys of the fetus and of the new-born child are distinctly lobed.

The excretory duct system of the kidney begins at the renal sinus as the *renal calices*, which, on the one hand, are attached to the lateral borders of the papillae and at the other pass into the *renal pelvis*, an enlargement of the ureter (see below) in the sinus and usually also in the region of the hilus. Usually several calices unite to form a single stem before they reach the pelvis and accordingly *greater* and *lesser calices* are recognized. The number of the latter corresponds with that of the papillae; that of the greater calices varies greatly. The *renal pelvis* corresponds in shape to the renal sinus and is a short, flattened, somewhat funnel-shaped tube, but shows, however, much individual variation.

The Ureter.

The ureter is an almost cylindrical canal 30 cm in length. It begins at the apex of the renal pelvis and terminates by opening into the lower posterior part of the bladder. It has an *abdominal* and a *pelvic portion*. In the empty state it is flattened; its musculature is weak, so that its walls are lax. In the distended condition it has the caliber of a small pencil; it is somewhat narrowed in its pelvic portion.

Fig. 486. The right suprarenal gland from in front. ($^1/_1$)
Fig. 487. The left suprarenal gland from in front. ($^1/_1$)
Fig. 488 and 489. Transverse sections of the suprarenal gland. ($^1/_1$)
Fig. 490. The bladder and prostate from in front. ($^9/_{10}$)

The bladder and prostate are opened from their anterior surfaces by a longitudinal incision and the bladder also by a horizontal cut. * = openings of the prostatic glands. Sounds are placed in the openings of the ejaculatory ducts.

The Suprarenal Glands.

The *suprarenal glands* are paired, ductless glands, seated on the upper ends of the kidneys. The left one has usually a somewhat crescentic form, while the right is more triangular, the apex being upwards. Each has an *anterior* and *posterior* surface and the concave surface in contact with the kidney is the *base*. Each has also a *medial* and a *superior border* and the right one has an *apex*. On the anterior surface there is a shallow groove, the *hilus*, where vessels and nerves enter or leave the gland.

Sections through the gland show that it is composed of a compact, yellow or brownish *cortical substance*, completely enclosing a soft, greyish-red *medullary substance*. The latter, in addition to numerous nerves, contains large blood vessels, their lumina being visible to the naked eye in sections.

The Urinary Bladder, *vesica urinaria*.

The *urinary bladder (vesica urinaria)* is an unpaired bladder-like structure in which the upper part, which is conical in the newborn child, is termed the *vertex*, the middle part the *body* and the lower part, turned towards the perineum, the *fundus*. When full it is usually ellipsoidal, but when completely emptied it is almost spherical, or, in the female, bowl-shaped by being compressed by the uterus above. From the vertex the *middle umbilical ligament* arises, this being the remains of the embryonic *urachus*. In the new-born child it still shows remains of a lumen.

The bladder has three orifices, those of the two ureters and that of the urethra. They lie within 1—2 cm of one another at the fundus, the urethral orifice at the lowest portion of the bladder, those of the ureters in the lower part of the posterior wall. The ureters traverse the wall of the bladder obliquely and so produce two converging folds, the *ureteric folds*, which are continued beyond the orifices for some distance, gradually fading out. Further the two ureteric openings are connected by a low transverse elevation, so that there is formed a triangular area, the *trigone*, at each of whose angles one of the orifices is situated and whose surface is smooth even in contraction, whereas the surface of the rest of the organ is rugose. Usually a ridge, the *uvula*, extends from the apex of the trigone to the urethral orifice.

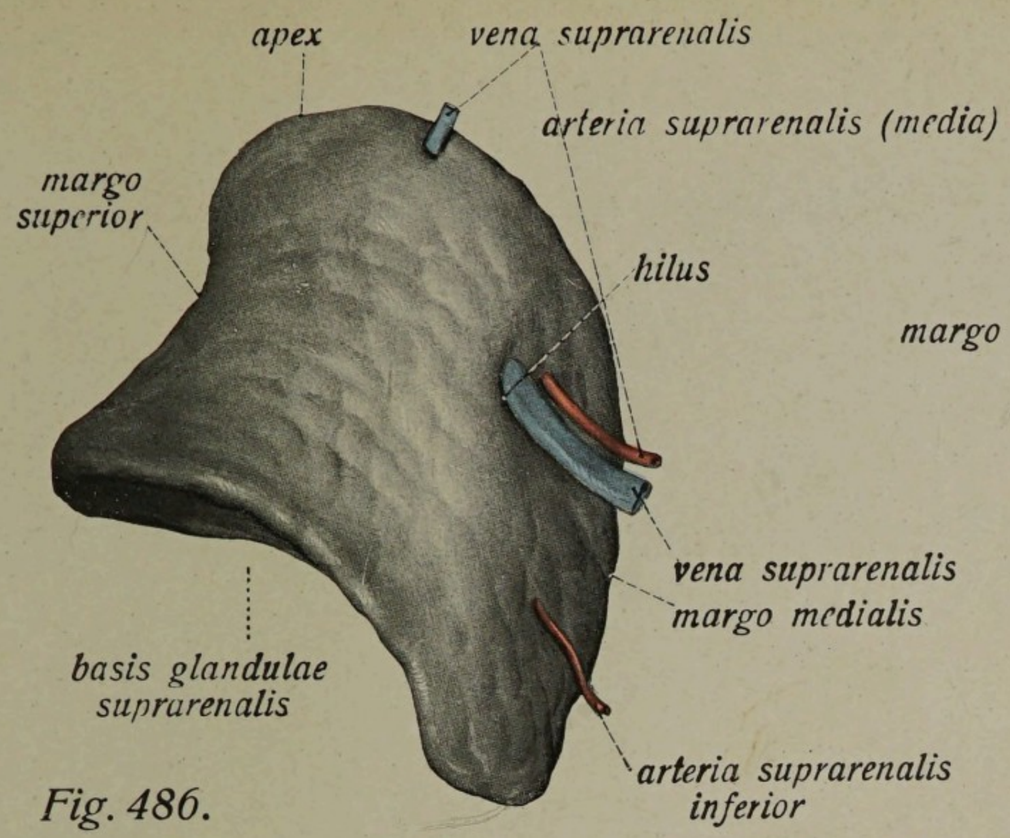


Fig. 486.

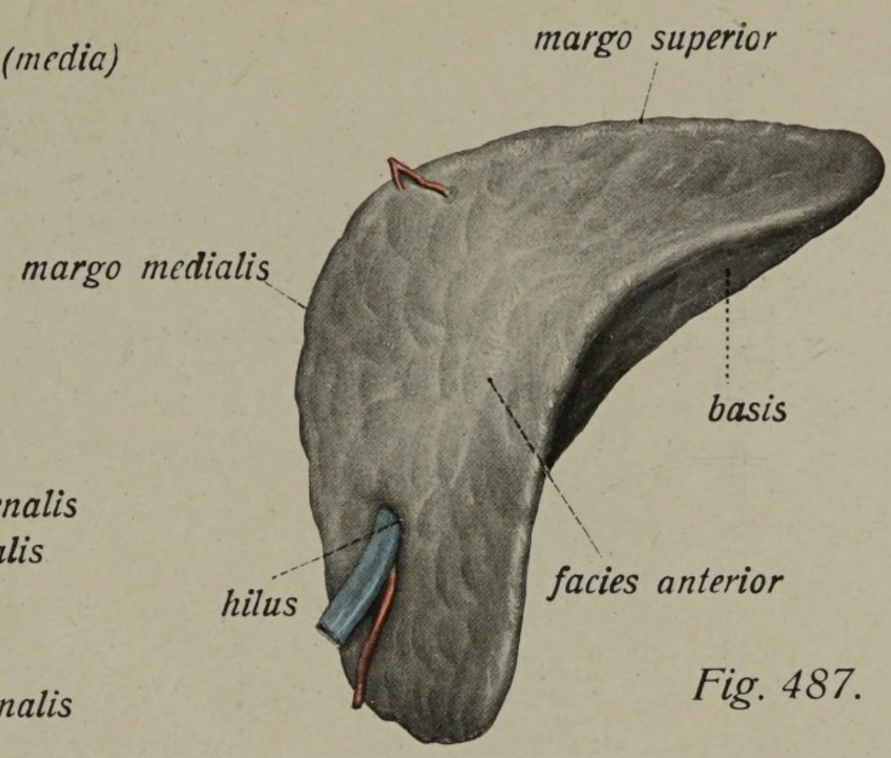


Fig. 487.

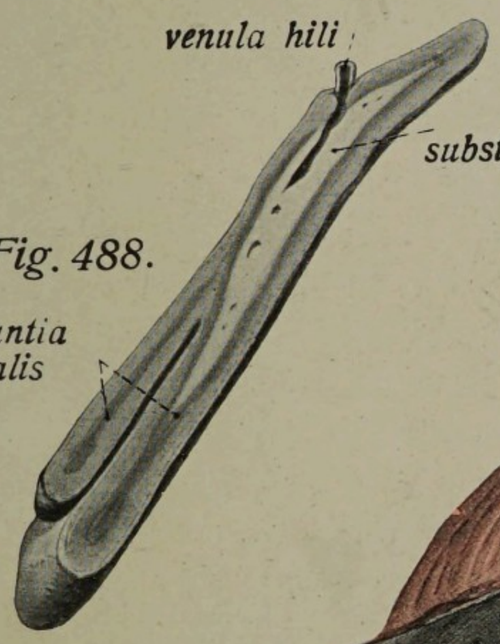


Fig. 488.

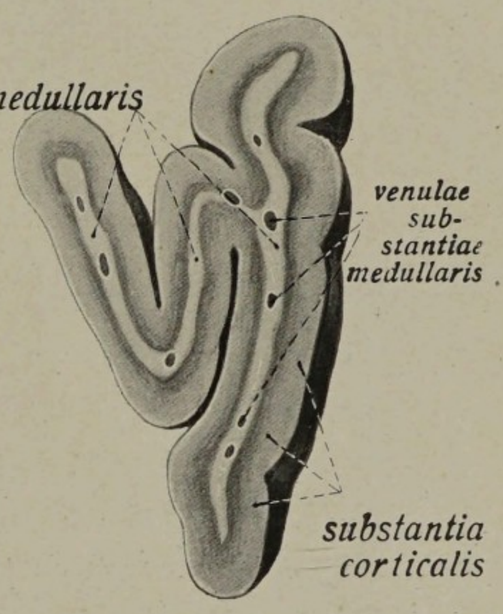
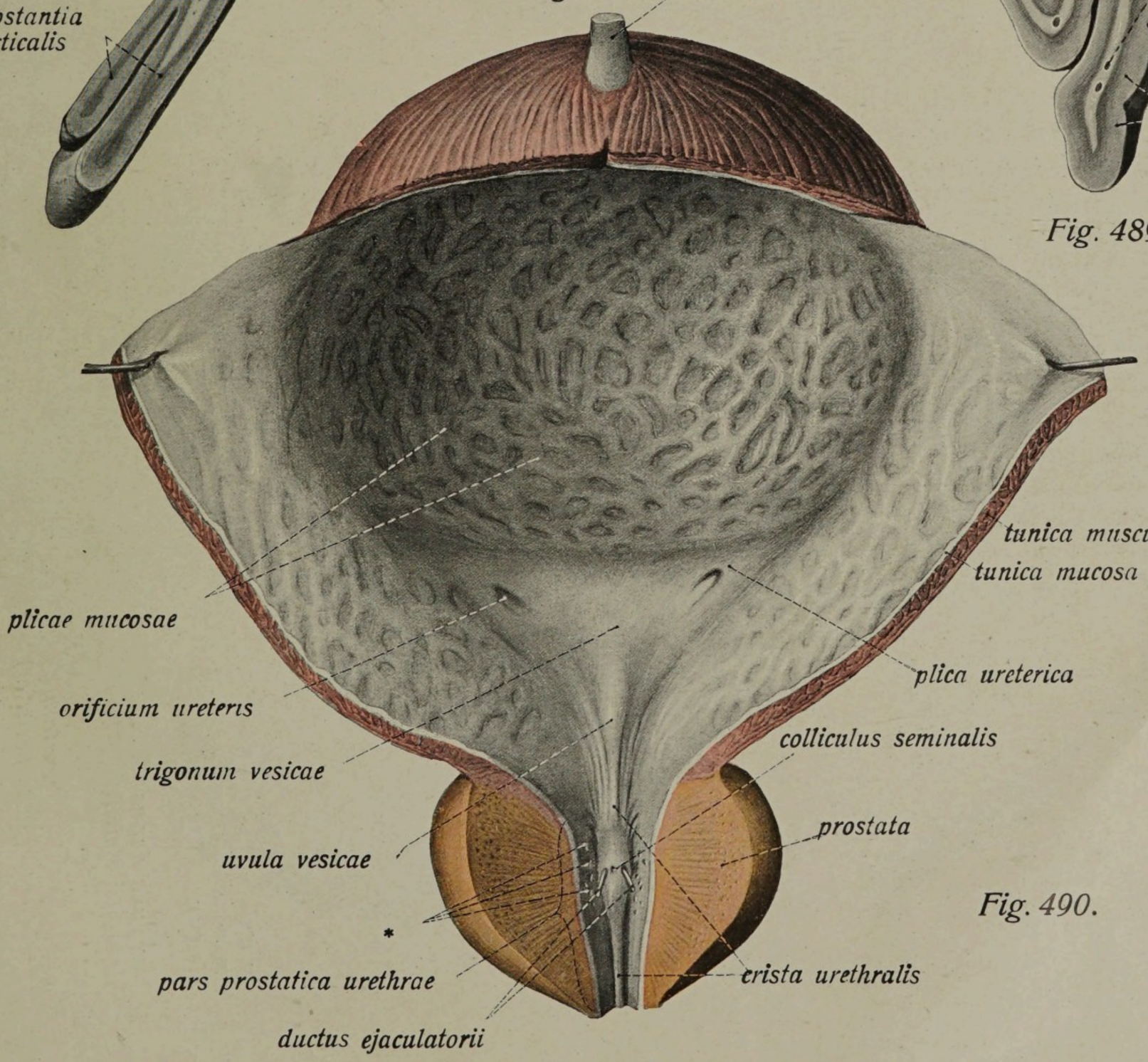


Fig. 489.



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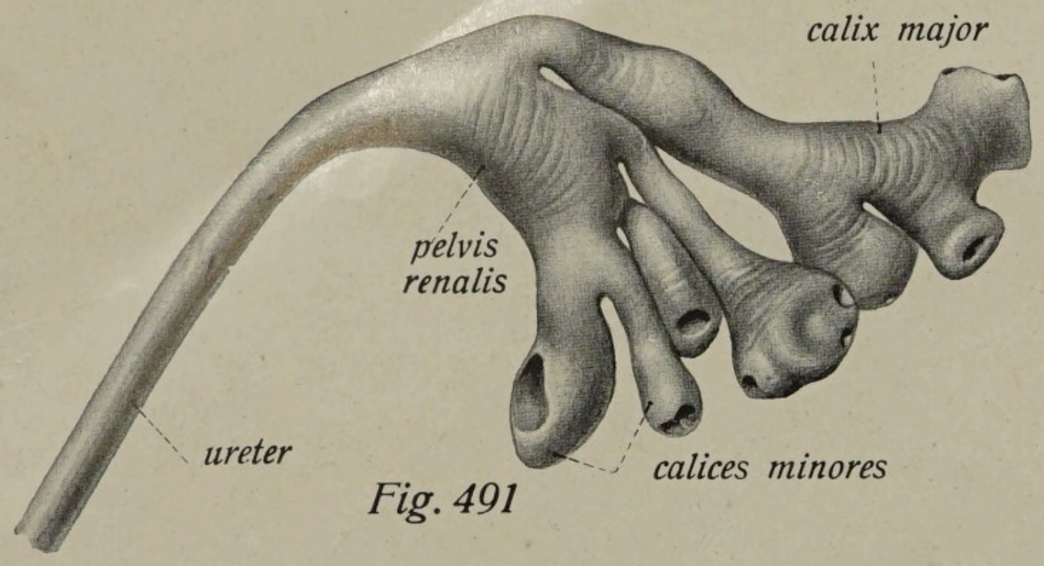


Fig. 491

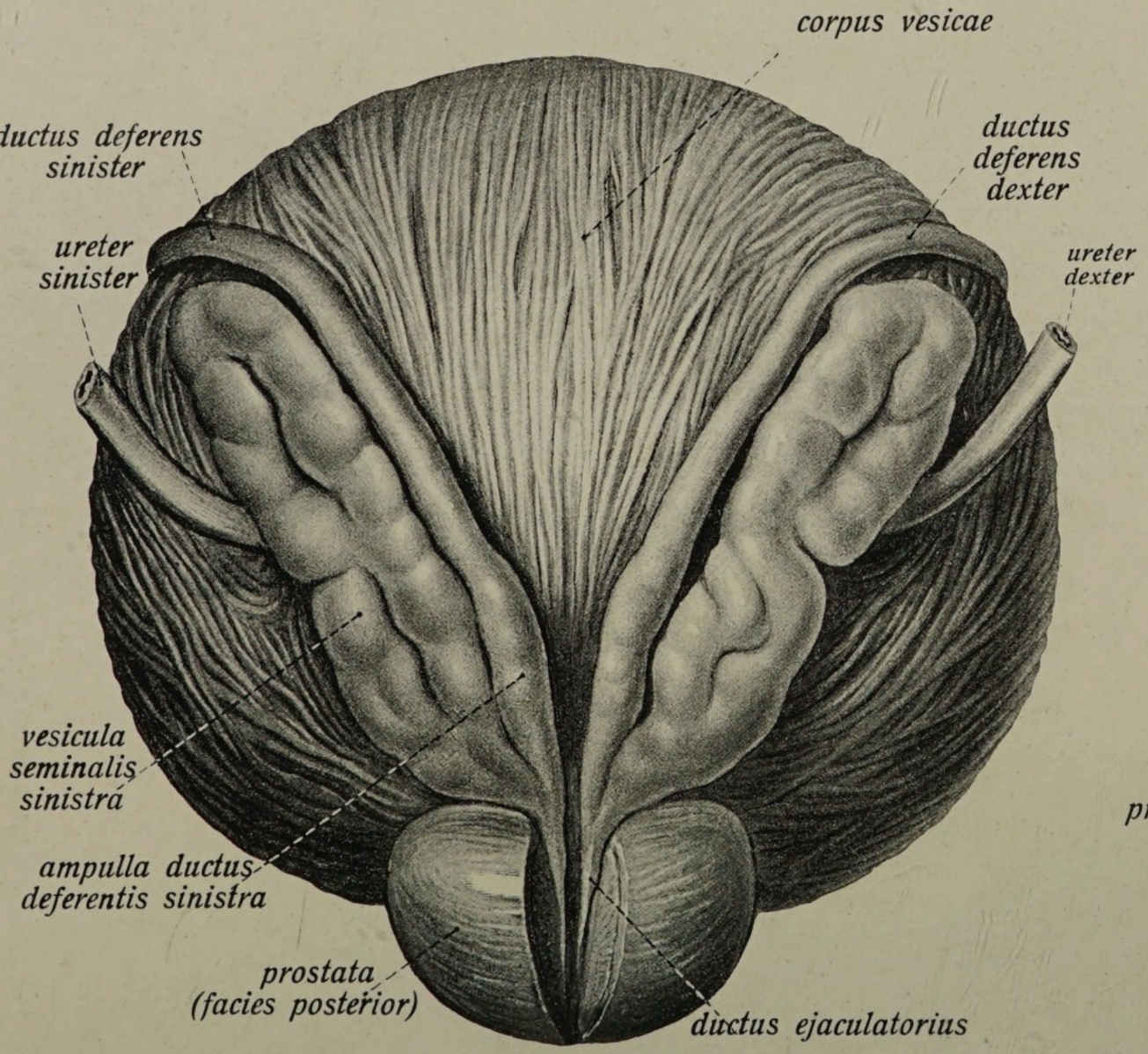


Fig. 492.

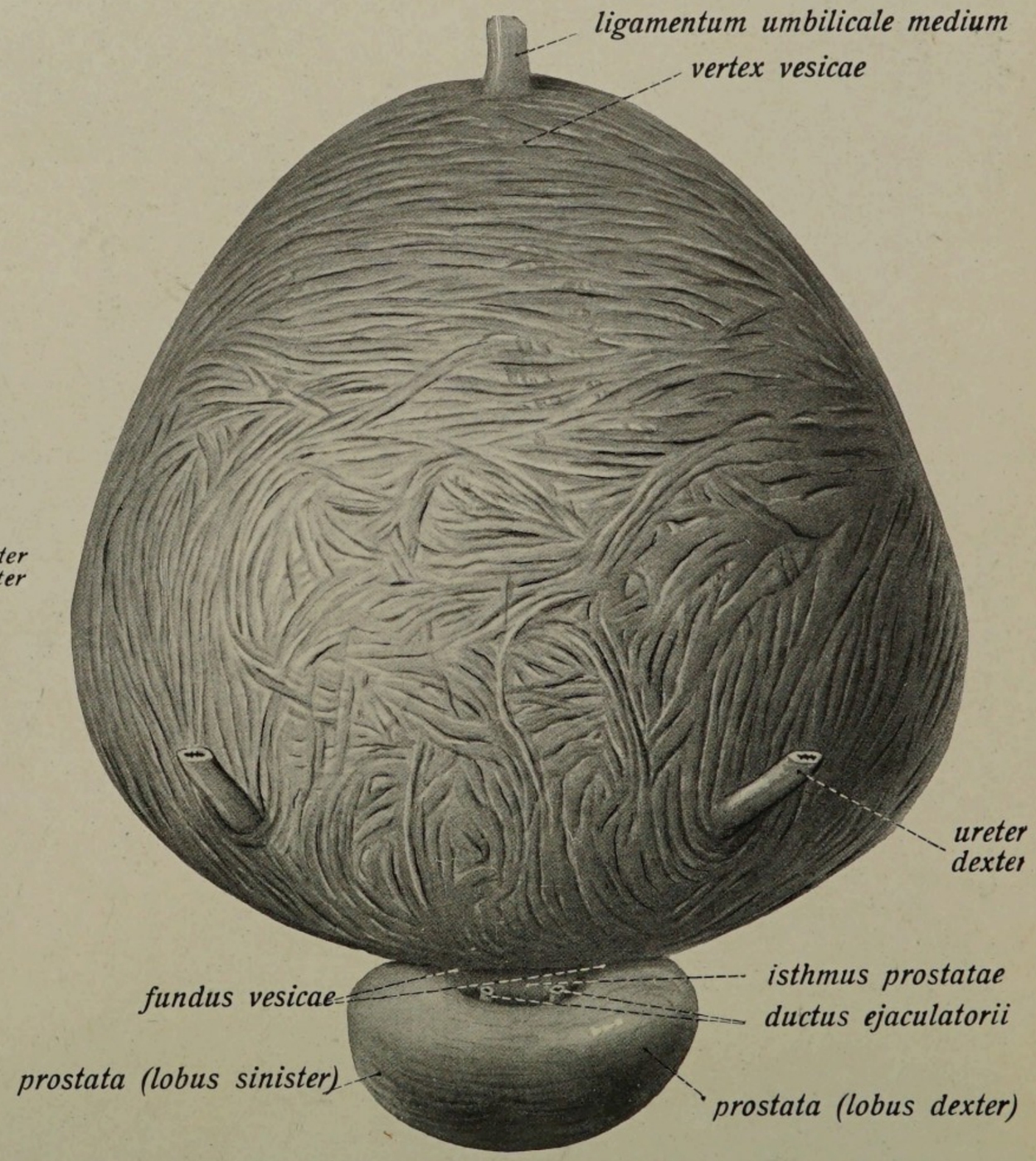


Fig. 493.

The Urogenital Organs. The Bladder and Prostate.

The wall of the bladder consists of the *mucous membrane*, a muscular coat and a *serous coat*, which, however, covers only the upper surface up to the apex and the upper parts of the lateral surfaces, being reflected posteriorly upon the rectum in the male and upon the uterus in the female. It does not extend over the posterior wall beyond the upper ends of the seminal vesicles in the male. The muscular coat consists of three layers. The outer one consists mainly of longitudinal fibres. The middle one is the strongest of the three and consists of an almost continous sheet of circular fibres, which become more oblique in the upper part and have an almost transverse direction in the lower part. A thickening of the layer at the urethral orifice is the *anulus urethralis* and serves as a sphincter of the bladder. The inner muscular layer is a net-like, wide-meshed sheet, immediately beneath the mucosa; the fibres have a general longitudinal tendency.

The Prostate.

The *prostate* is a glandulo-muscular structure, situated at the lower end of the bladder. It is of firm consistence and is a thickening of the upper part of the wall of the urethra, so arranged that it is thinner and lower anteriorly and thicker and higher posteriorly. The broad, upper surface united to the bladder is the *base*, and the strongly rounded *apex* is directed downwards and forwards. A slight furrow on the posterior surface divides the chief mass of the gland into two imperfectly separated portions, the *right* and *left lobes*. A transverse groove, due to the entrance of the ejaculatory ducts, separates an anterior lobe, termed the *isthmus*. The *posterior surface* is almost flat, the *anterior surface* is much shorter and almost vertical. The two surfaces pass into one another by rounded convex lateral surfaces. The prostate is distinctly flattened from before backwards. Half of its substance is smooth muscle tissue, the *m. prostaticus*, and the other half is gland substance. This is made up of a number (30—50) of individual glands, which open, by about 10—15 *prostatic ducts*, into the prostatic portion of the urethra. In correspondence with the stronger development of the glands in the posterior portion of the organ, the orifices of the ducts are mainly on the posterior wall of the urethra, especially on the lateral slopes of the *colliculus seminalis* and in the groove alongside it; the part of the organ situated in front of the urethra is destitute of glandular tissue.

Fig. 491. A cast of the human renal pelvis. ($^1/_1$)
Fig. 492. The bladder with the seminal vesicles, the ampulla of the ductus deferens and prostate, from behind and below. ($^1/_1$) The prostate is partly divided longitudinally to show the ejaculatory ducts.
Fig. 493. The bladder and prostate from behind. ($^1/_1$) The superficial musculature has been dissected away.

The Urogenital Organs (Cont.), The Male Genitalia.

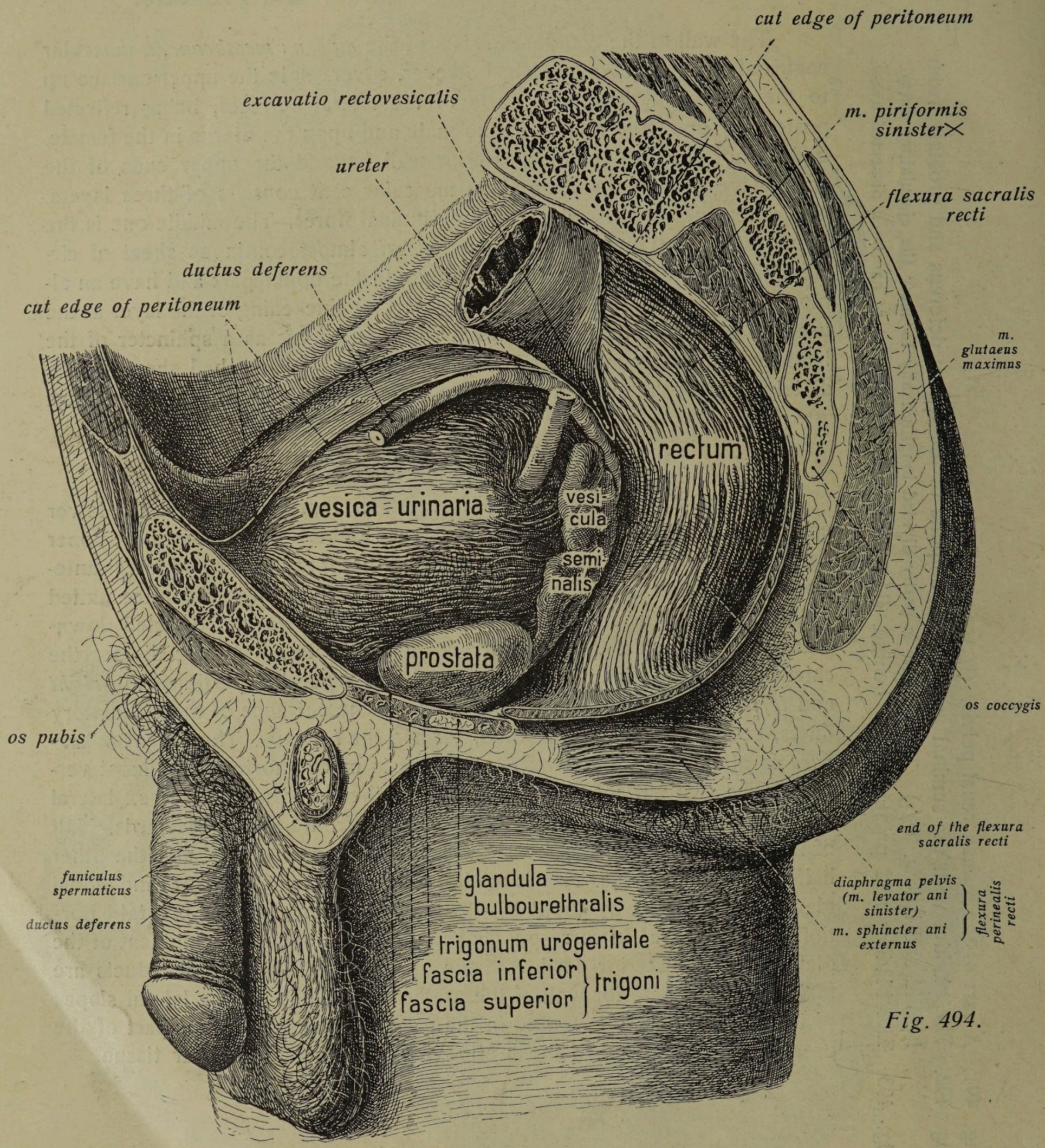
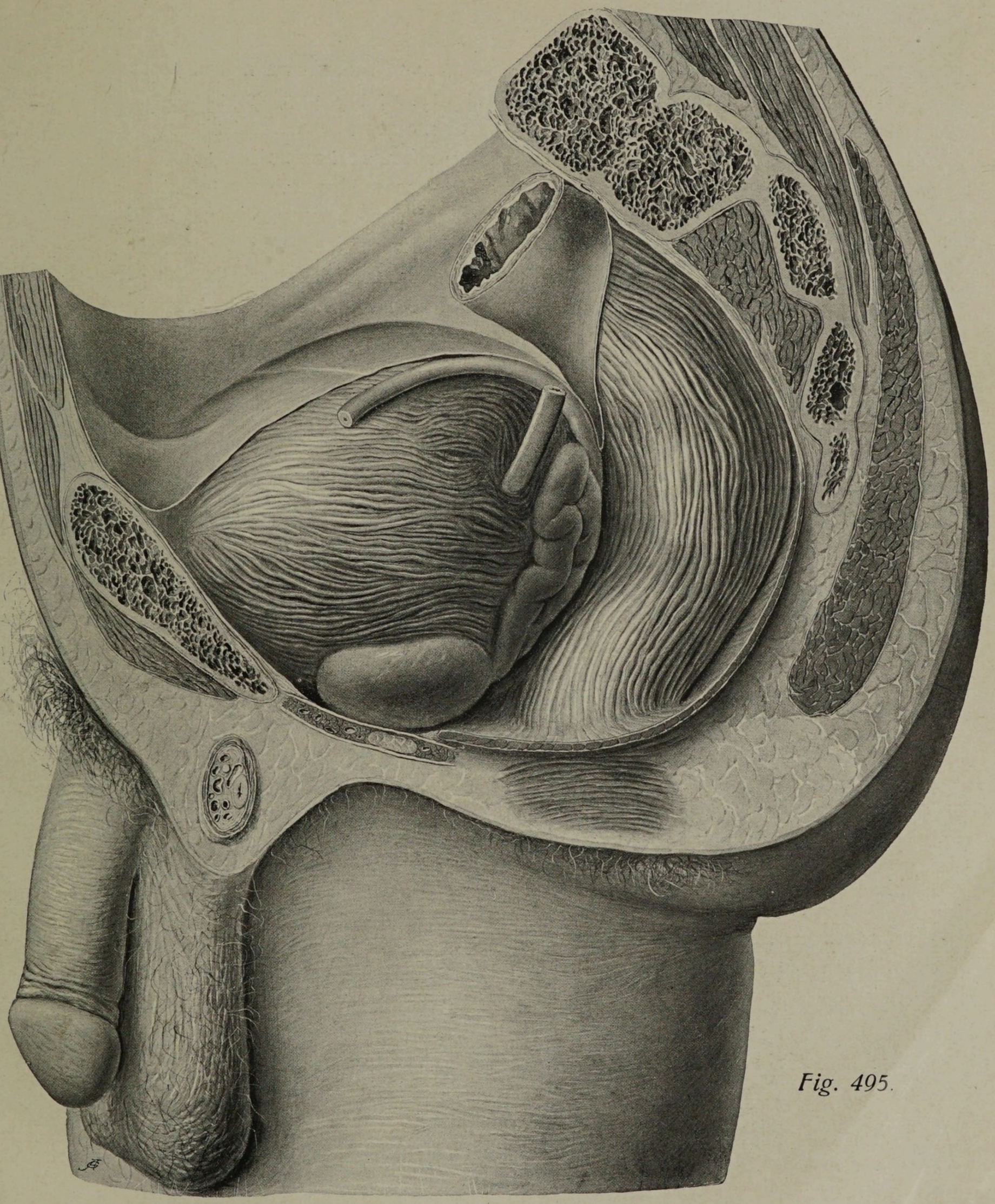


Fig. 494.

Figs. 494 and 495. A profile view of the male genitalia. ($^2/_3$)
The sacrum and coccyx are divided a few centimetres from the median line and the peritoneum is dissected away from the lateral wall of the bladder.



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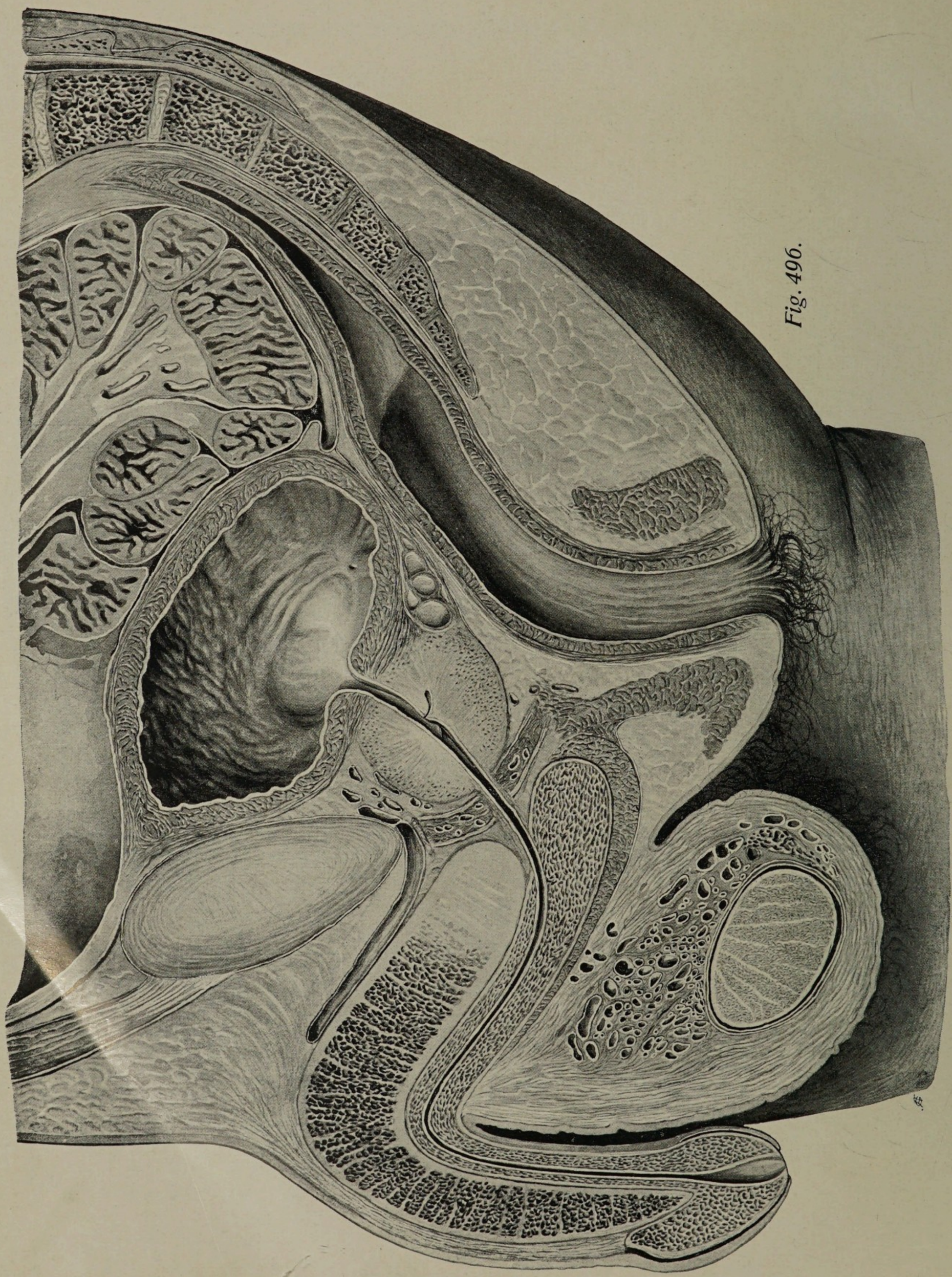

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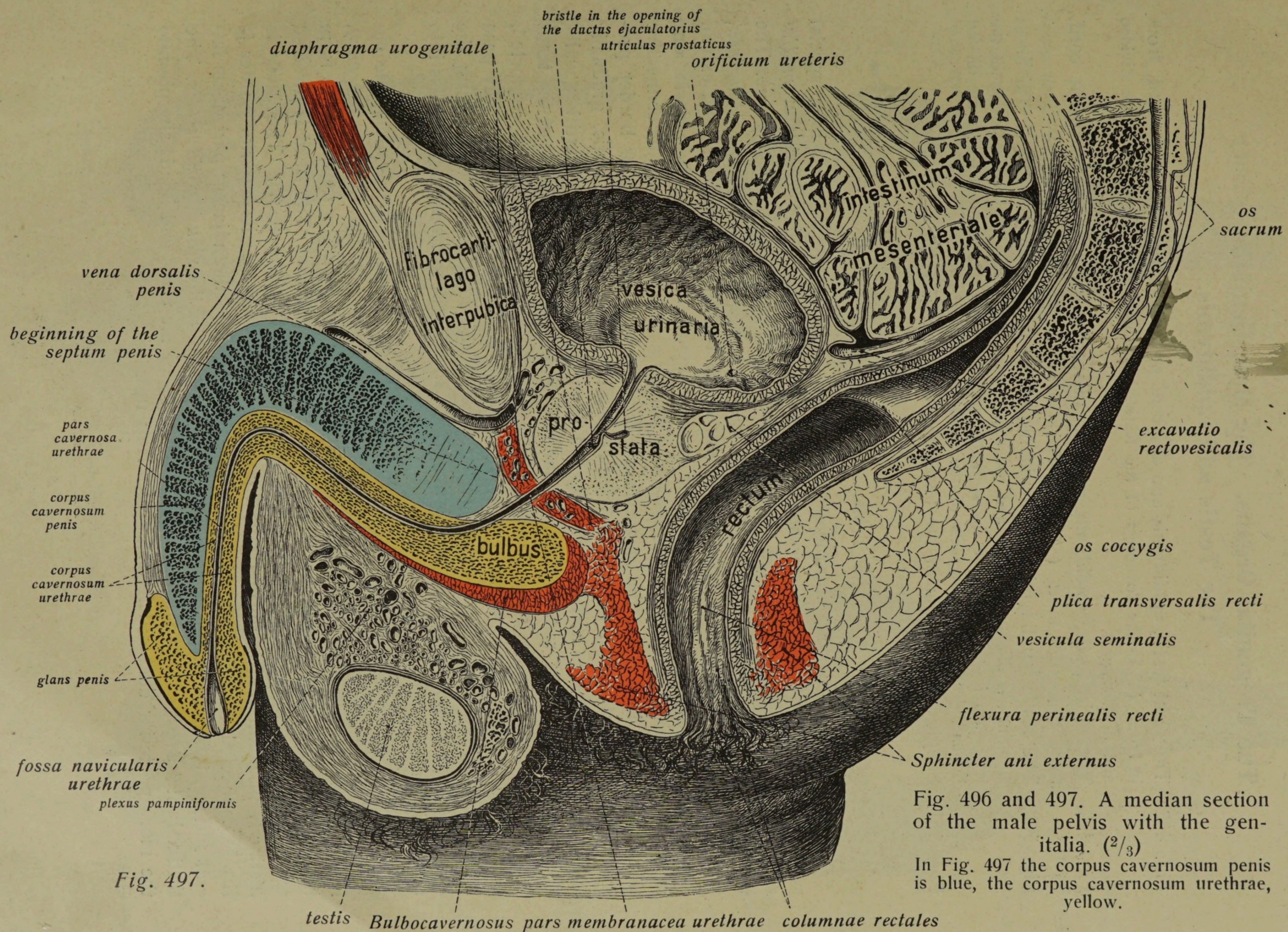


Fig. 497.

Fig. 496 and 497. A median section of the male pelvis with the genitalia. ($^2/_3$)

In Fig. 497 the corpus cavernosum penis is blue, the corpus cavernosum urethrae, yellow.

The Urogenital Organs. The Male Genitalia. (Cont.)
The Testis and Epididymis.

Fig. 498. The right testis, epididymis and adjacent portion of the spermatic cord, from in front. ($^4/_5$) The coverings of the testis, including the tunica vaginalis are divided and drawn apart.

Fig. 499. The right testis, epididymis and the adjacent portion of the spermatic cord, from the outer side. ($^4/_5$) Preparation as in Fig. 498.

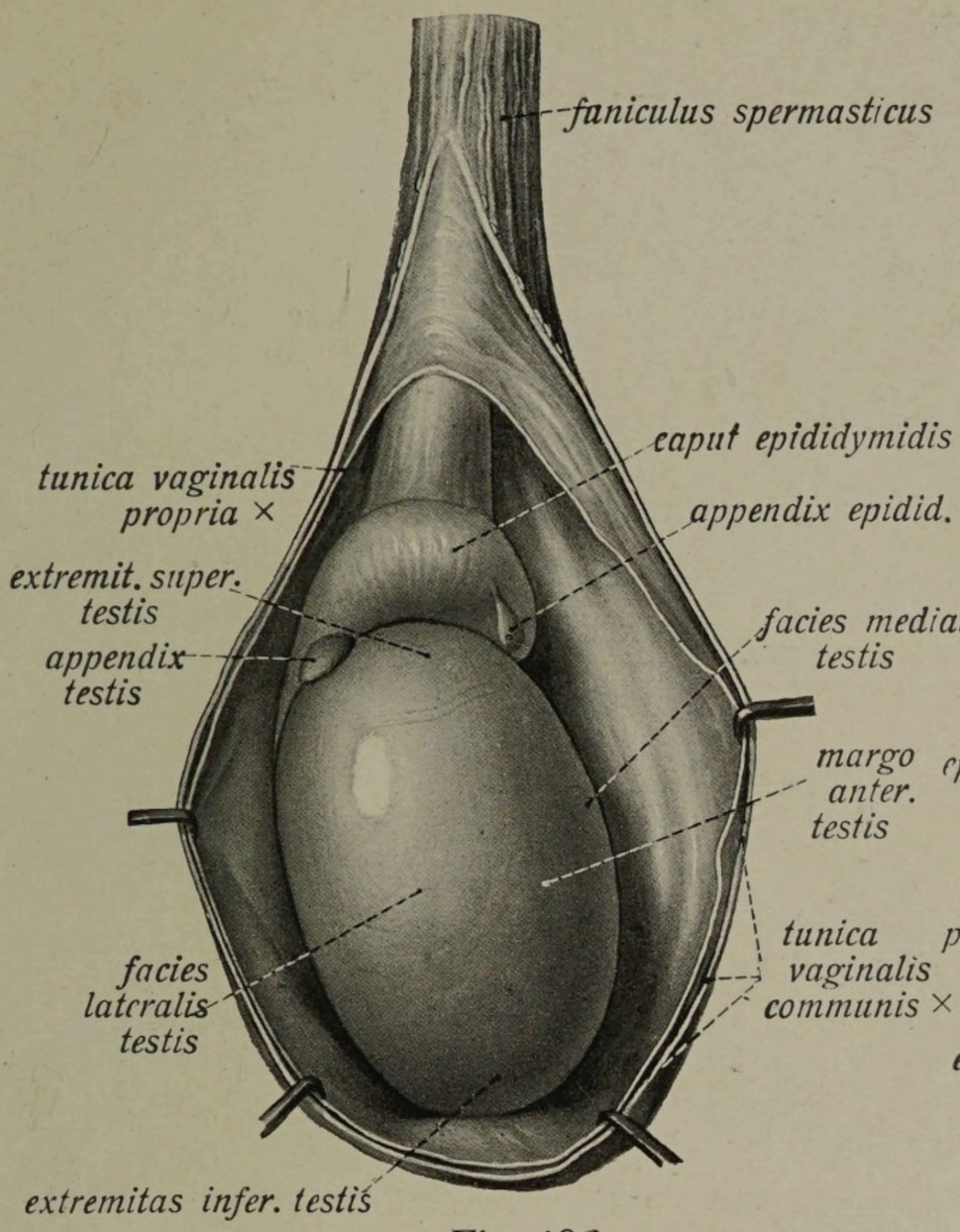
Fig. 500. The testis, epididymis and beginning of the ductus deferens. ($^5/_4$) The tunica albuginea is mostly removed and the seminiferous tubules of the lower portion of the testis are frayed out. The ducts of the epididymis and the ductus deferens are dilated by an injection. The vessels of the testis are cut off short.

Fig. 501. Longitudinal section of the testis and epididymis. ($^5/_4$)

The Testis and Epididymis.

The *testis* is a paired, ellipsoidal structure, enclosed in the scrotum in a special serous covering. It has a *superior* and an *inferior extremity* and *lateral* and *medial surfaces,* the latter being separated by well rounded *anterior* and *posterior borders.* The testis is covered by a firm, white capsule of connective tissue, the *tunica albuginea,* which is pierced towards the posterior border of the testis for the entrance and exit of vessels and nerves. The posterior border is consequently fixed, while the anterior one is free. In addition there is on the posterior border a keel-shaped mass of connective tissue, triangular in section, the *mediastinum testis,* whose sharp anterior border projects into the substance of the testis. It is decidedly shorter than the testis, gradually fading out both upwards and downwards, and from it connective tissue partition walls, the *septula testis,* pass radially towards the tunica albuginea. The *lobules* of the testis between these contain the *seminiferous tubules,* slender, much curved and contorted, white tubules, large enough to be seen by the naked eye. In the mediastinum they pass into straighter, much narrower, anastomosing tubules, the *tubuli recti,* which form the *rete testis.* From the base of the mediastinum 10—15 efferent ducts emerge to pass into the epididymis.

The *epididymis* is a long, club or retort-shaped body, which extends along the entire length of the posterior border of the testis. In its middle portion, the *body (corpus),* it is a triangular-prismatic, but becomes enlarged and rounded at its upper end to form the *head (caput),* while its lower end is termed the *tail (cauda).* The head is directed medially and its under surface rests on the upper end of the testis. The body is distinctly prismatic and is the narrowest portion of the structure; its anterior border is firmly connected with the posterior border of the testis and the adjacent part of its lateral surface, but otherwise it is separated from the testis by the *sinus epididymidis.* The distinctly flattened, curved tail lies at the lower end of the testis and bends sharply into the more posterior ductus deferens, which runs upwards.



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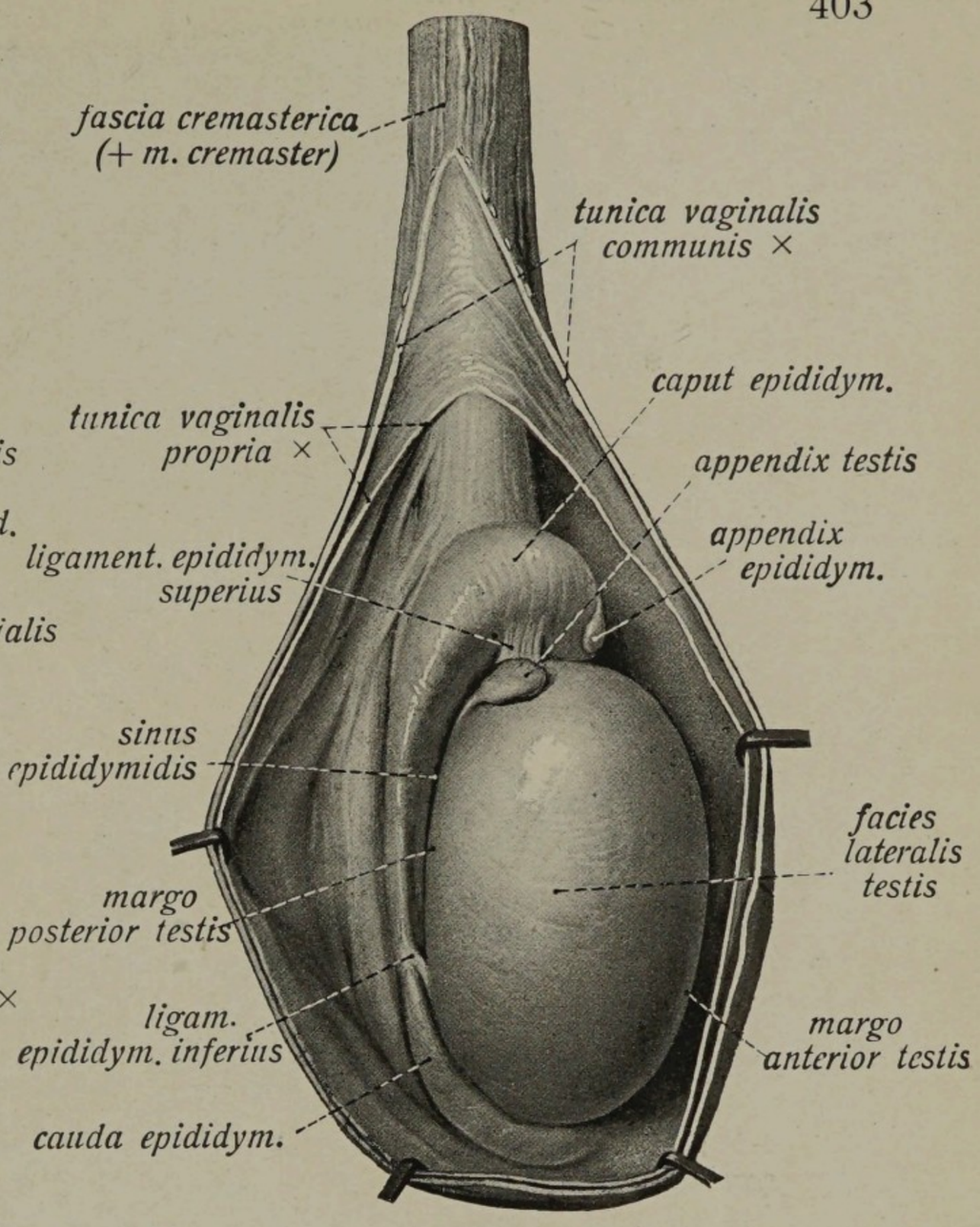

Fig. 499.

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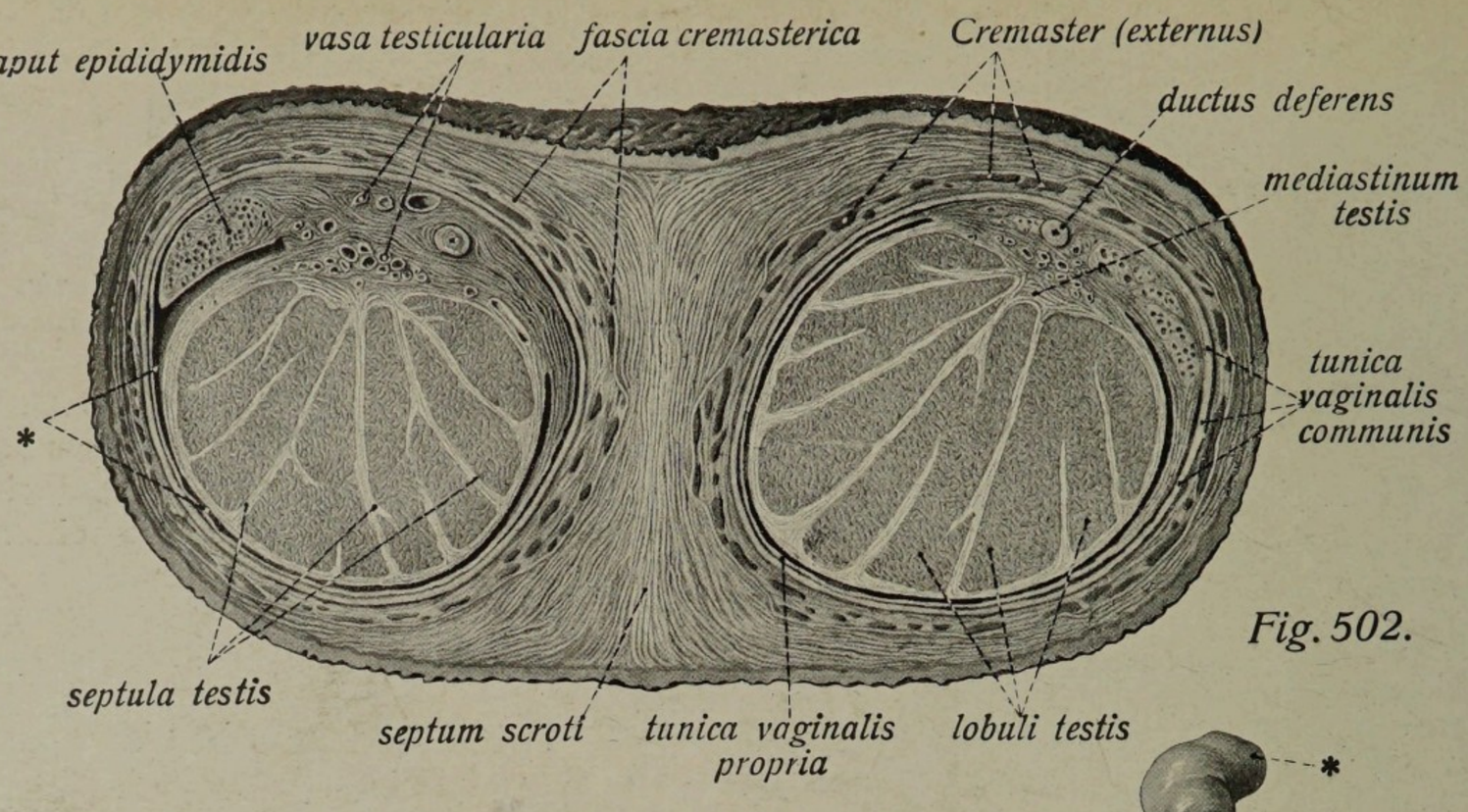

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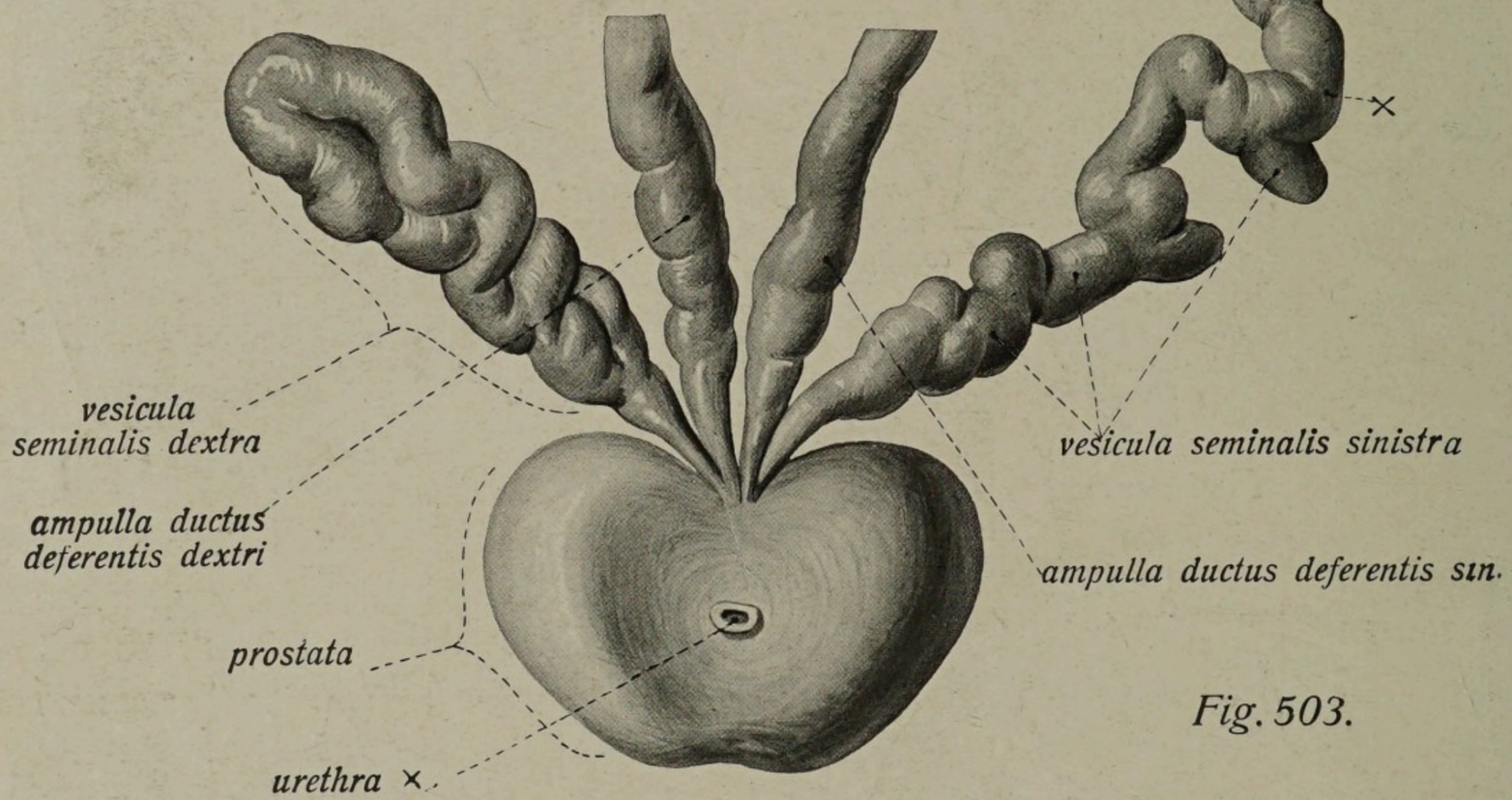

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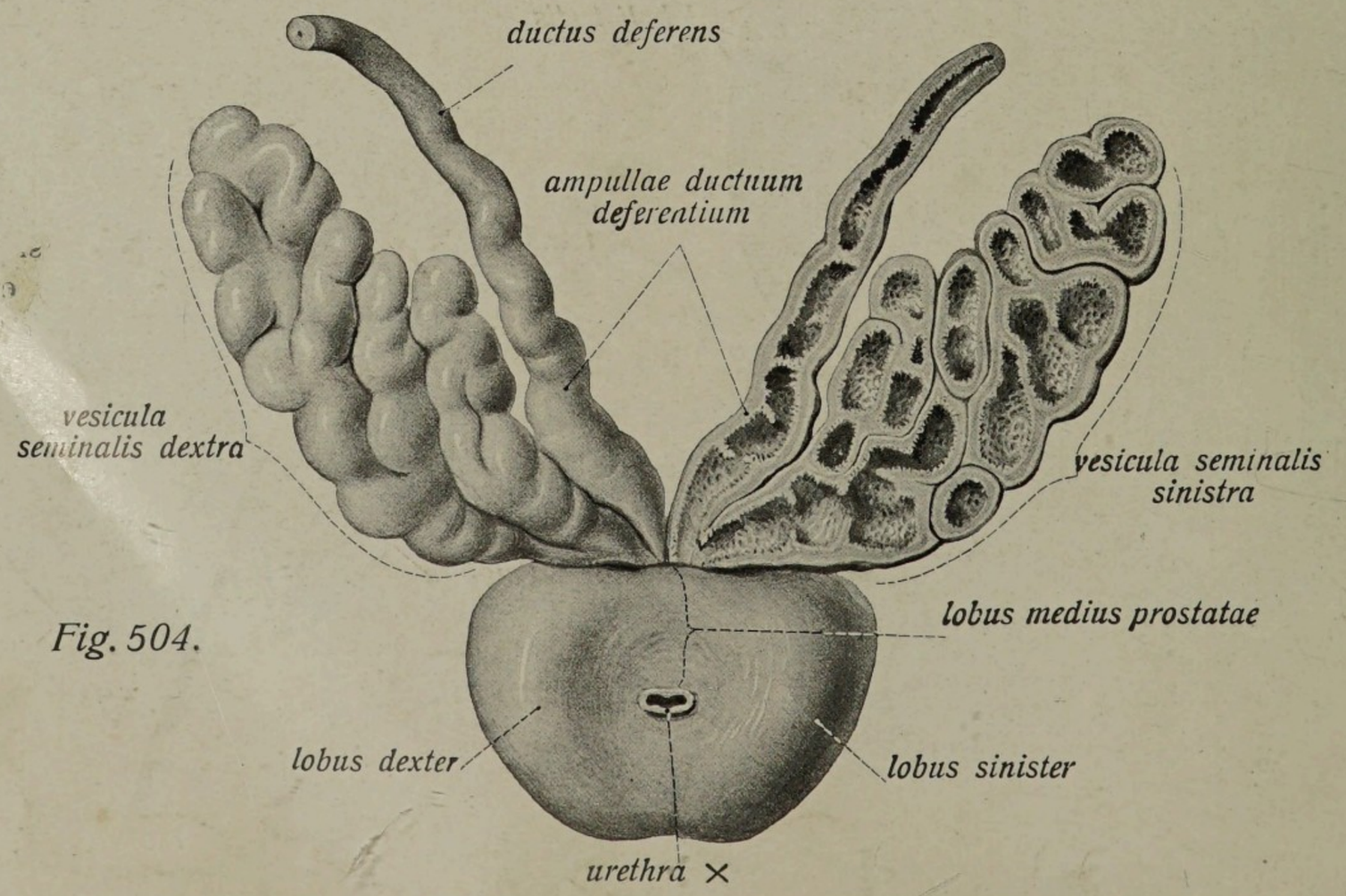


Fig. 504.

The Urogenital Organs. The Male Genitalia. (Cont.)
The Epididymis, Spermatic Cord and Seminal Vesicles.

Fig. 502. Transverse section of the scrotum and both testes. ($^5/_4$) * = cavity of the tunica vaginalis.

Fig. 503. The prostate with the seminal vesicles and the ampulla of the ductus deferens. ($^1/_1$) The left seminal vesicle is uncoiled. * = the blind end of the vesicle. × = the apparent end as it lies on the bladder.

Fig. 504. The prostate with the seminal vesicles, from above and in front. ($^1/_1$) The left vesicle and ampulla of the ductus deferens are divided frontally; the urethra is cut off at its exit from the bladder, so that one sees the concave base of the prostate.

In the head of the epididymis the efferent ducts of the testis become much contorted, forming the conical *lobuli epididymidis* and these unite with an exceedingly long *ductus epididymidis*, which is very greatly contorted, its closely appressed coils forming the body and tail of the epididymis. At the end of the tail this duct, gradually ceasing to be coiled, becomes continuous with the ductus deferens. The testis and epididymis are contained within a serous membrane, the *tunica vaginalis*, whose visceral layer covers the testis completely, except over the area where the vessels enter, and the epididymis partly, being reflected from the head and tail of the latter to the posterior surface of the testis, forming the *superior* and *inferior epididymal ligaments*. Between these and between the body of the epididymis and the testis is a cleft-like pouch of the vaginal cavity, the *sinus epididymis*. On the upper end of the testis, and like it covered by the tunica vaginalis, is an appendage, the *appendix testis* (sessile hydatid), and frequently another such structure, the *appendix epididymidis* (stalked hydatid) is attached to the head of the epididymis.

The Ductus Deferens and Seminal Vesicle.

The *ductus deferens* is a cylindrical canal, about 40 cm. in length, which begins at the tail of the epididymis, passes upwards parallel to the epididymis, becomes enclosed in the spermatic cord and passes with this through the inguinal canal. Then, after traversing the true pelvis, it reaches the back of the bladder, where it becomes enlarged to form the *ampulla*, and then unites with a seminal vesicle to form the *ejaculatory duct*, which opens into the prostatic portion of the urethra. Its wall is thick and muscular and its lumen quite small; consequently it is firm to the touch. In the interior of the ampulla the mucous membrane is thrown into numerous branching and anastomosing folds, associated with which there may be irregular outpouchings of the wall, the *diverticala ampullae*. The two ampullae become narrower below and converge.

The *seminal vesicles* are elongated, flattened bodies, which are attached, one on either side, to the lower end of the ampulla of the ductus deferens. Towards their blind upper ends they enlarge to form the *body (corpus)*, but become more slender below. The surface of each is irregularly lobulated. Actually each seminal vesicle is a single, broad, contorted tube, with blind outpouchings of its walls, the various loops and outpouchings being firmly bound together by connective tissue. The blind end of the tube really lies some distance below what seems to be its upper end, this being merely one of the bends of the tube. The lumina of the vesicles are much wider than that of the ductus deferens, wider, indeed, than that of the ampulla, and the mucous membrane is thrown into strong folds.

The Urogenital Organs. The Male Genitalia. (Cont.)
The Scrotum and Spermatic Cord.

Fig. 505. The scrotum and spermatic cord from in front. ($^1/_1$)
On the left the cremasteric fascia is split and the cremaster muscle exposed. On the right all the coverings of the spermatic cord are split and a window is cut in the tunica vaginalis. The penis is drawn upwards and its fascia and the superficial perineal fascia is partly removed, so that the anterior end of the bulbo-cavernosus muscle is exposed.

The Scrotum and Spermatic Cord.

The skin of the scrotum passes without any boundary into that of the mons pubis, the perineum and the medial surface of the thigh. It is thin, distinctly pigmented and darker than the neighboring skin; it possesses large sebaceous glands, a few strong hairs and a distinct median *raphe*, which corresponds to the *septum* within. This is a partition which separates the two testes and spermatic cords and is formed of connective tissue, some fatty tissue and some smooth muscle fibres. Furthermore the skin of the scrotum possesses an extensive layer of smooth muscle fibres, the *tunica dartos*; the fibres are arranged in a network.

Beneath the dartos is the *cremasteric fascia*, which is continued downwards from the superficial abdominal fascia over the *cremaster muscle* and follows this to the scrotum. The muscle is an extension of the Obliquus abdominis internus and runs in scattered, at first longitudinal and parallel, bundles on the posterior surface of the spermatic cord, but in the scrotum the bundles take oblique and transverse courses. They lie directly upon the fascial membrane, the *tunica vaginalis communis*, which is a continuation of the fascia transversalis of the abdomen and is so called because it forms a common sheath for the spermatic cord and the testis. The *tunica vaginalis propria* is the inner tunic of the testis. There are thus in the scrotum the following layers: the skin with the tunica dartos, the cremasteric fascia, the cremaster muscle, the tunica vaginalis communis and the tunica vaginalis propria.

The spermatic cord *(funiculus spermaticus)* is a roundish cord about the thickness of the little finger and 12—15 cm in length. It extends from the inguinal canal to the upper end and posterior margin of the testis and contains as its chief constituents the *ductus deferens* behind and the *testicular vessels* in front, the veins that it contains forming a wide-meshed network, the *pampiniform plexus*. In addition it contains the deferential artery and vein, and the lymph vessels and nerves of the testis group themselves in the anterior and lateral parts of the spermatic cord, those of the ductus deferens in the posterior and medial parts. Furthermore there is in the cord the *rudiment of the vaginal process*, and in its lower portion the *paradidymis;* also smooth muscle fibres, the *cremaster internus*. The coverings of the cord are a rather loose connective tissue, poor in fat, the cremasteric fascia, the cremaster externus and the tunica vaginalis communis.

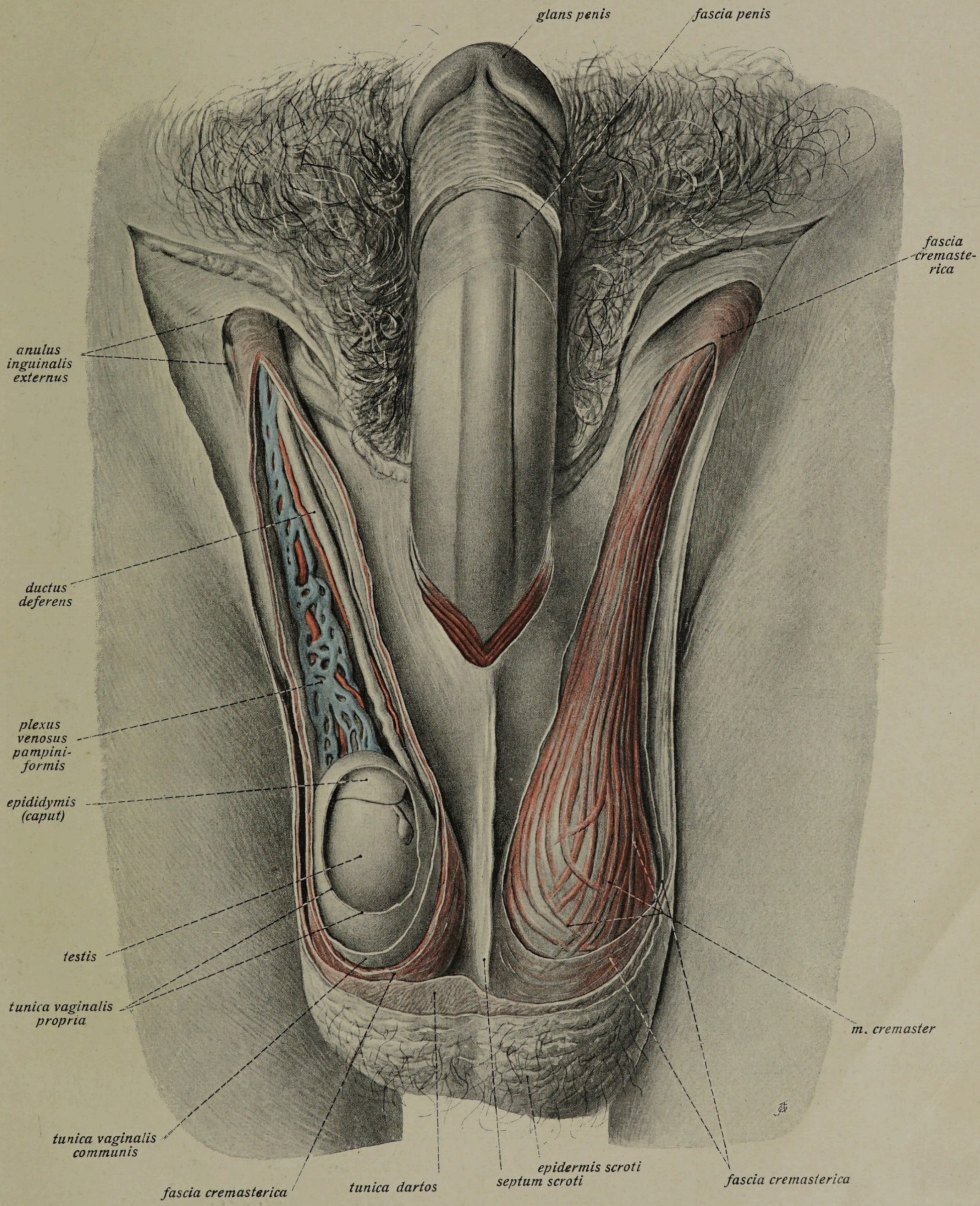
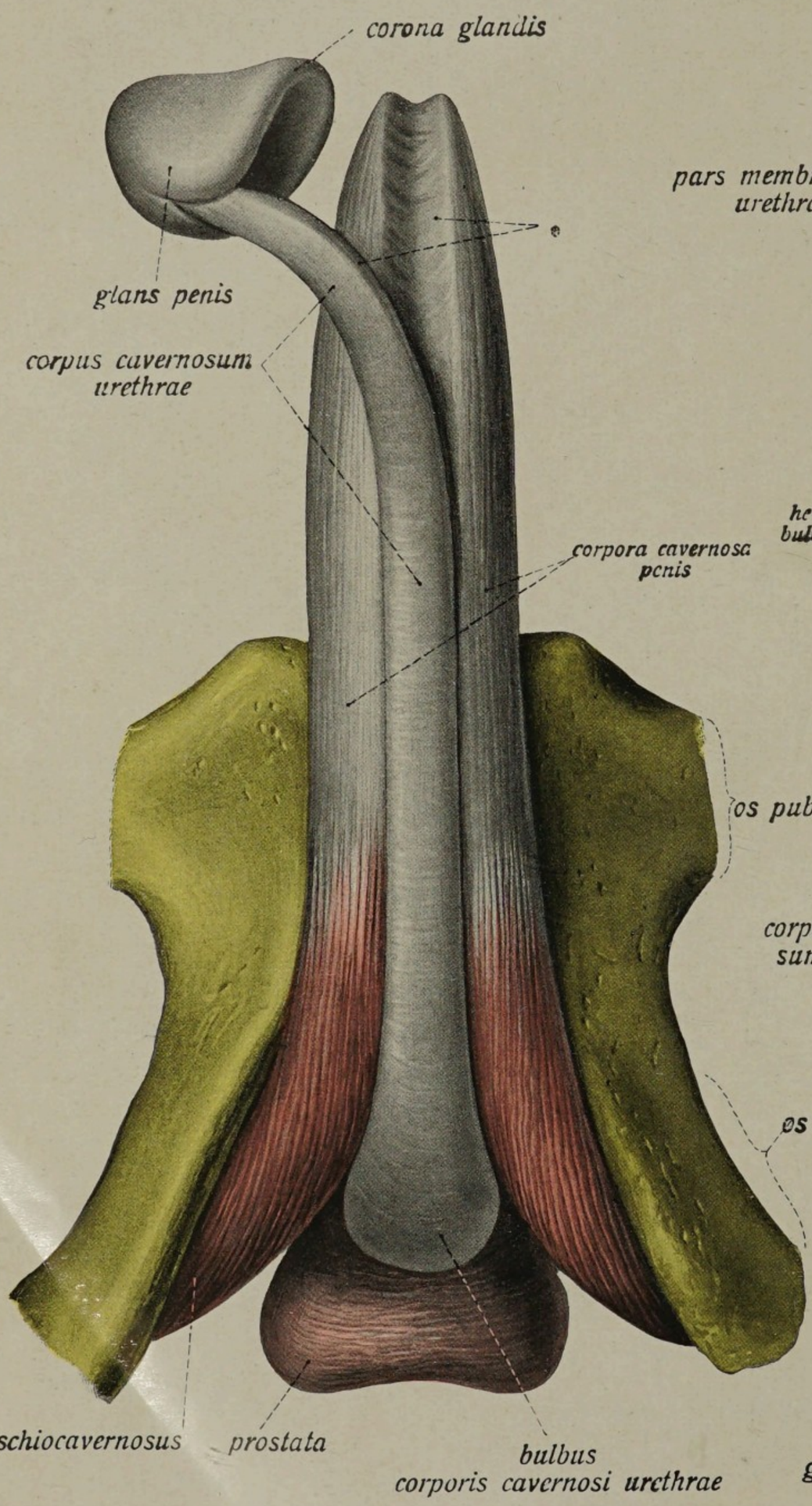

glans penis
fascia penis
fascia cremasterica
anulus inguinalis externus
ductus deferens
plexus venosus pampiniformis
epididymis (caput)
testis
tunica vaginalis propria
tunica vaginalis communis
fascia cremasterica
tunica dartos
epidermis scroti
septum scroti
fascia cremasterica
m. cremaster

Fig. 505.



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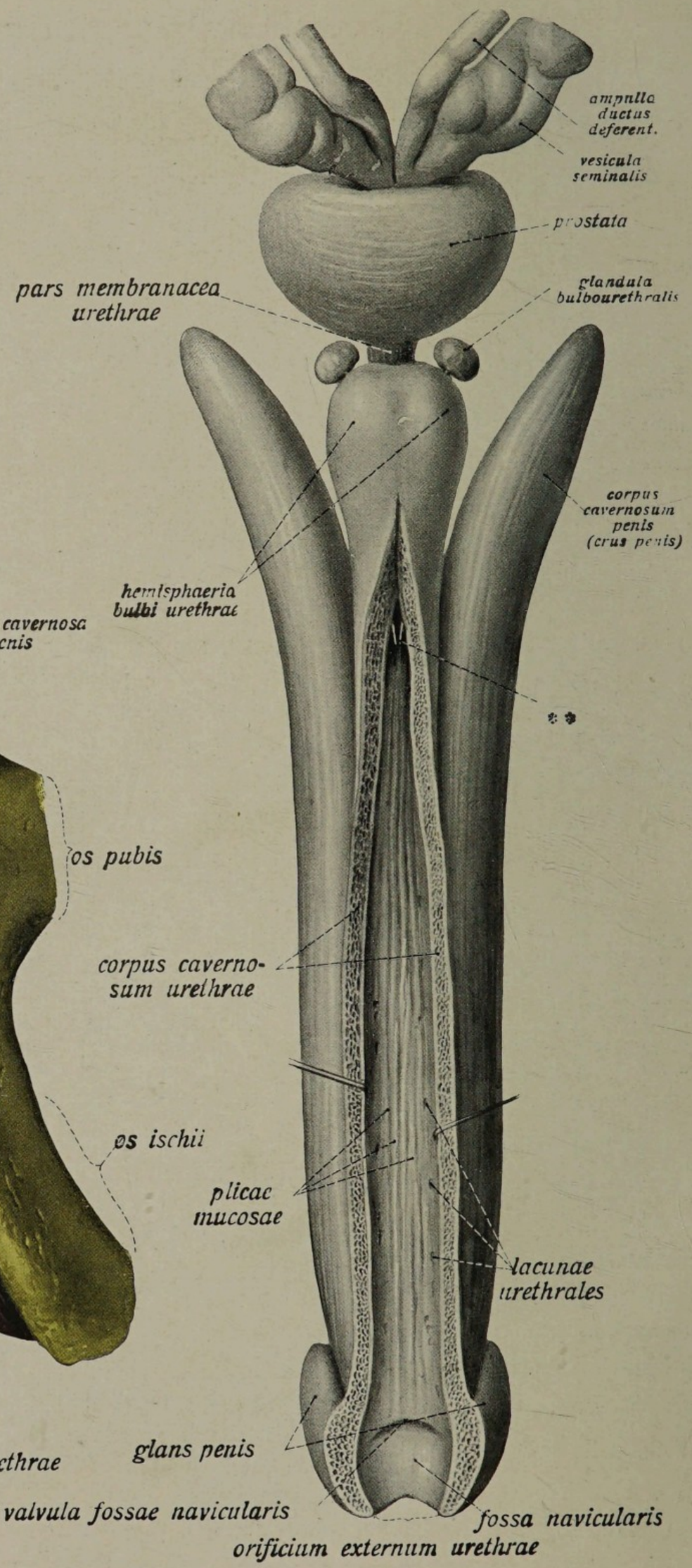


Fig. 507.

The Urogenital Organs. The Male Genitalia. (Cont.)
The Male Urethra and the Penis.

Fig. 506. The erectile bodies of the penis. The glans penis and the anterior part of the corpus cavernosum urethrae are raised. * = point of contact of the two in the natural position.

Fig. 507. The male urethra with the corpora cavernosa penis, the bulbo-urethral glands and the prostate.
The cavernous portion of the urethra is opened along its under surface. ** = sounds in the openings of the bulbo-urethral glands.

The Male Urethra.

The male *urethra*, which is about 20 cm in length, consists of a *prostatic portion*, a *membranous portion* and a *cavernous portion*. The first of these lies in the prostate, which is really its thickened wall, its lumen transversing the gland from base to apex. It shows a longitudinal fold on its posterior wall, the *urethral crest*, the highest part of which is termed the *colliculus seminalis*. Upon its apex is the opening of the *prostatic utriculus* (uterus masculinus) and laterally those of the ejaculatory ducts (see also p. 405). The membranous portion is about 1 cm in length and runs almost perpendicularly through the musculature of the urogenital trigone.

On either side of the posterior part of the membranous portion there is a roundish gland, the *bulbo-urethral* (Cowper's) *gland*, about the size of a pea and imbedded in the fibres of the transversus perinei. Its duct is very thin, but rather long (4—5 cm), and runs forwards and downwards through the bulb of the urethra to open into the urethra at the beginning of its cavernous portion.

The cavernous portion is much the longest part of the male urethra and its walls are the corpus cavernosum urethrae. In its proximal portion it is convex backwards, then follows a portion below the symphysis which is concave upwards, the concavity being quite independent of the position of the penis *(pars cavernosa fixa)*, and finally there is a portion in the pendulous part of the penis *(pars pendula)*. Consequently in the lax penis the urethra shows an S-shaped curve, but in the erect organ the lower curve is straightened out, only the upper one remaining. The caliber of the cavernous portion is fairly uniform, except for an enlargement close to the external orifice. This enlargement is termed the *fossa navicularis* (Morgagni) and on its dorsal wall it has a semilunar fold, the *valvula fossae navicularis* (lacuna magna).

The Penis.

The penis is an almost cylindrical body, which is fastened by its *root (radix)* to the pubic bones, its principal portion, the *body (corpus)*, hanging downwards when in a lax condition. The free thickened end is formed by the *glans*. It has a broader upper and anterior or *dorsal surface* and a somewhat smaller *urethral* surface, below and behind.

The chief constituents of the penis are the erectile *corpora cavernosa penis*, which are cylindrical bodies, tapering to a point anteriorly and posteriorly. They are fused together throughout the greater part of their extent. They take their origin from the medial borders of the inferior rami of the ischia by more slender flattened portions, the *crura penis*. In front of the lower part of the symphysis the two crura come together and their medial surfaces fuse to form the septum of the penis (see p. 410).

The Urogenital Organs. The Male Genitalia.
The Penis. (Cont.)

Fig. 508. The anterior end of the penis with the praeputial sack. ($^1/_1$) The skin of the penis is divided at the side and the prepuce is drawn away from the glans.

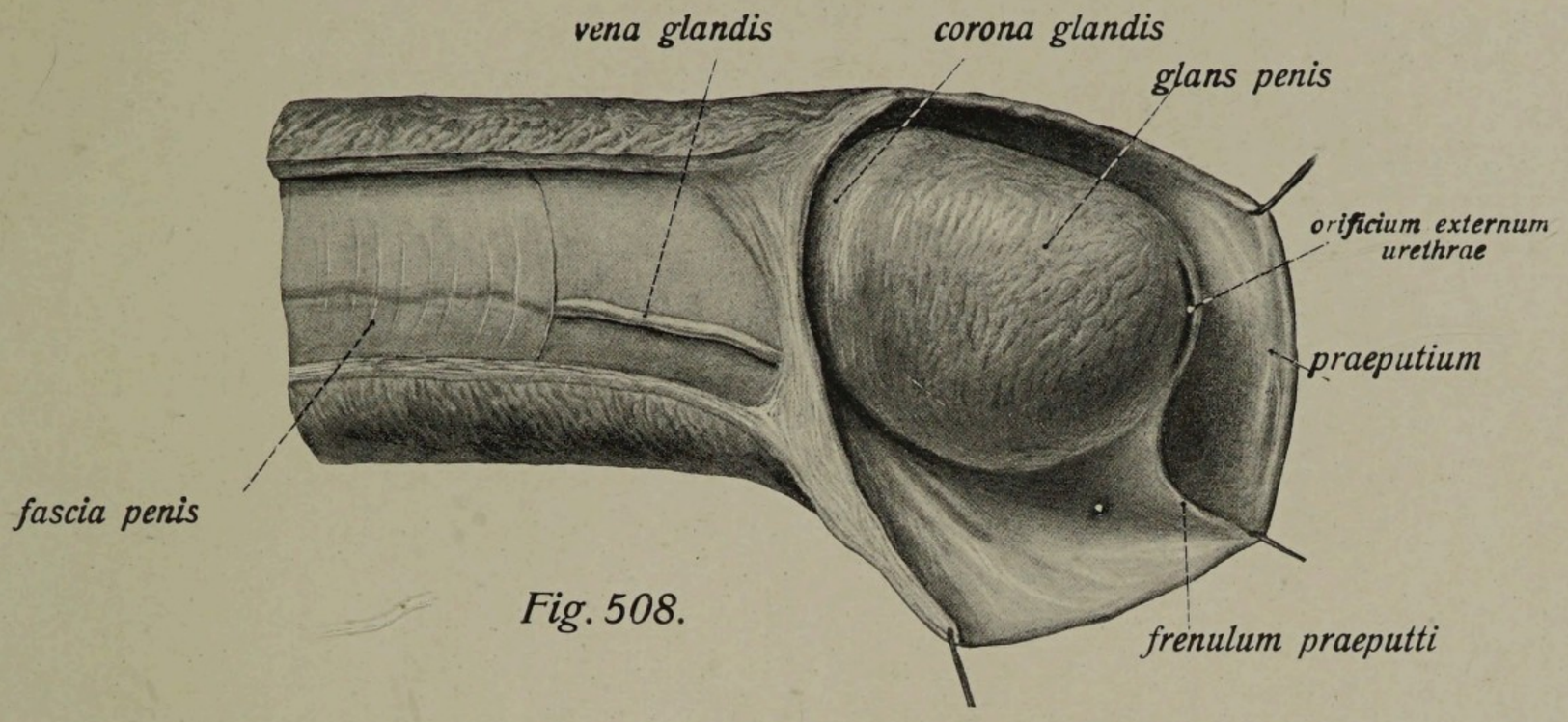
Fig. 509—512. Transverse sections of the penis through the middle of the body, at the hinder end of the glans, through the middle of the glans and at its tip. ($^5/_4$) Corpus cavernosum urethrae, yellow; corpus cavernosum penis, blue.

The pointed anterior ends of the two corpora cavernosa penis project under the corona of the glans. Each corpus has a very firm and thick covering of connective tissue, the *tunica albuginea*, and in the body of the penis, where the corpora are fused, it forms the *septum penis*.

The third, more slender, but longer, erectile body is the penis in the *corpus cavernosum urethrae*, a distinctly flattened cylindrical structure, enlarged posteriorly to form the *bulb* and anteriorly to form the *glans*. It forms the wall of the cavernous portion of the urethra. The bulb is somewhat pyriform in shape and shows a furrow or *sulcus* which separates two *hemispheres*, more distinctly separated in the interior by a *septum*.

The *glans penis* has the form of a short, broad oblique cone, with a rounded tip. Its convex dorsal surface is longer than the ventral one, which has a shallow groove. The base of the glans is excavated to receive the anterior ends of the corpora cavernosa penis and its free projecting border is termed the *corona*, the region just behind this being the *neck (collum)*. A *septum* extends from the albuginea upwards to the urethra.

The three corpora cavernosa are enclosed by a common, rather dense, connective tissue investment, which extends as far as the neck and is termed the *fascia penis*. It also encloses the dorsal vessels of the penis. At the neck of the glans the skin forms a strong fold, of greater or less extent, the *prepuce*. The skin covering the glans is very much thinner than usual, without hairs and with only occasional sebaceous glands; at the neck it is reflected forward so as to again cover the glans to a greater or less extent, and it then bends back upon itself to become continuous with the skin over the body of the penis. There is thus formed between the prepuce and the glans the *preputial sack*. The inner layer of the prepuce is bound to the glans by a *frenulum*, which is attached in the groove on the under surface of the glans.



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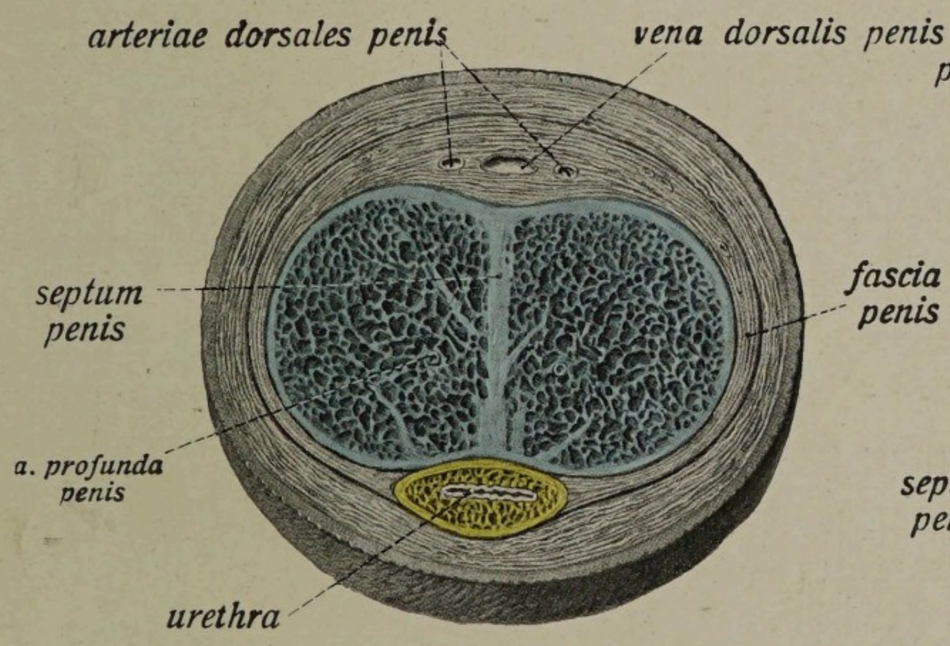

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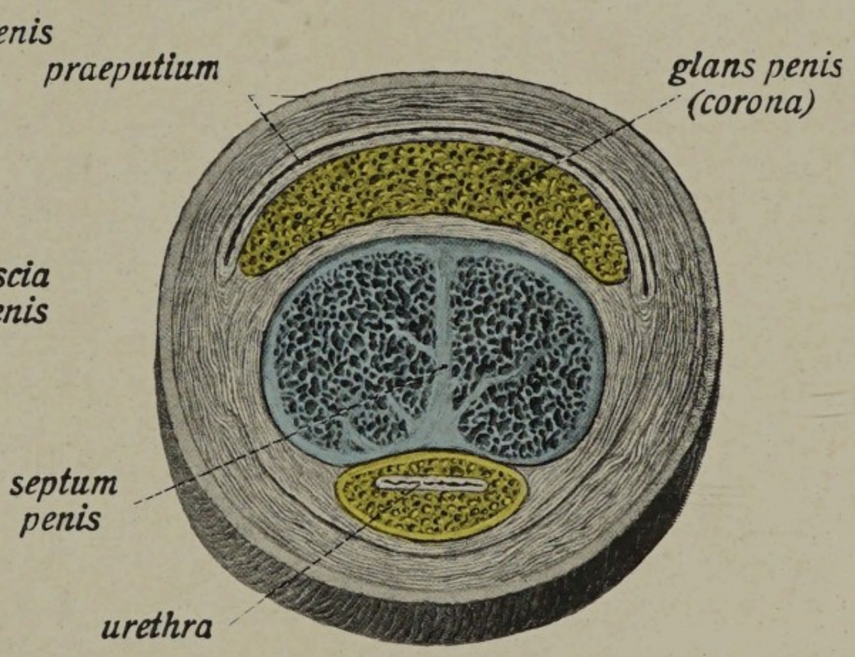

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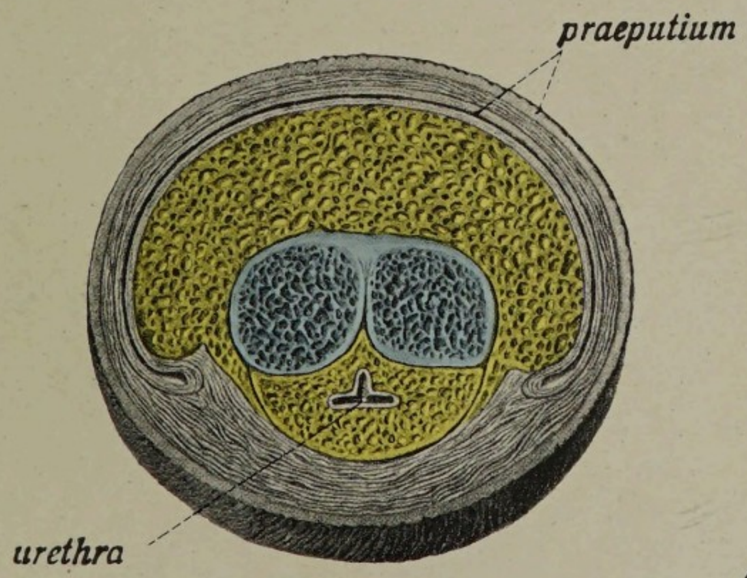

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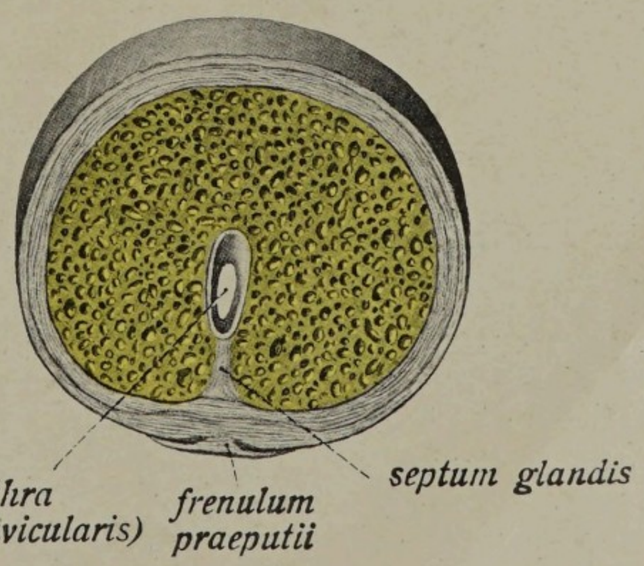

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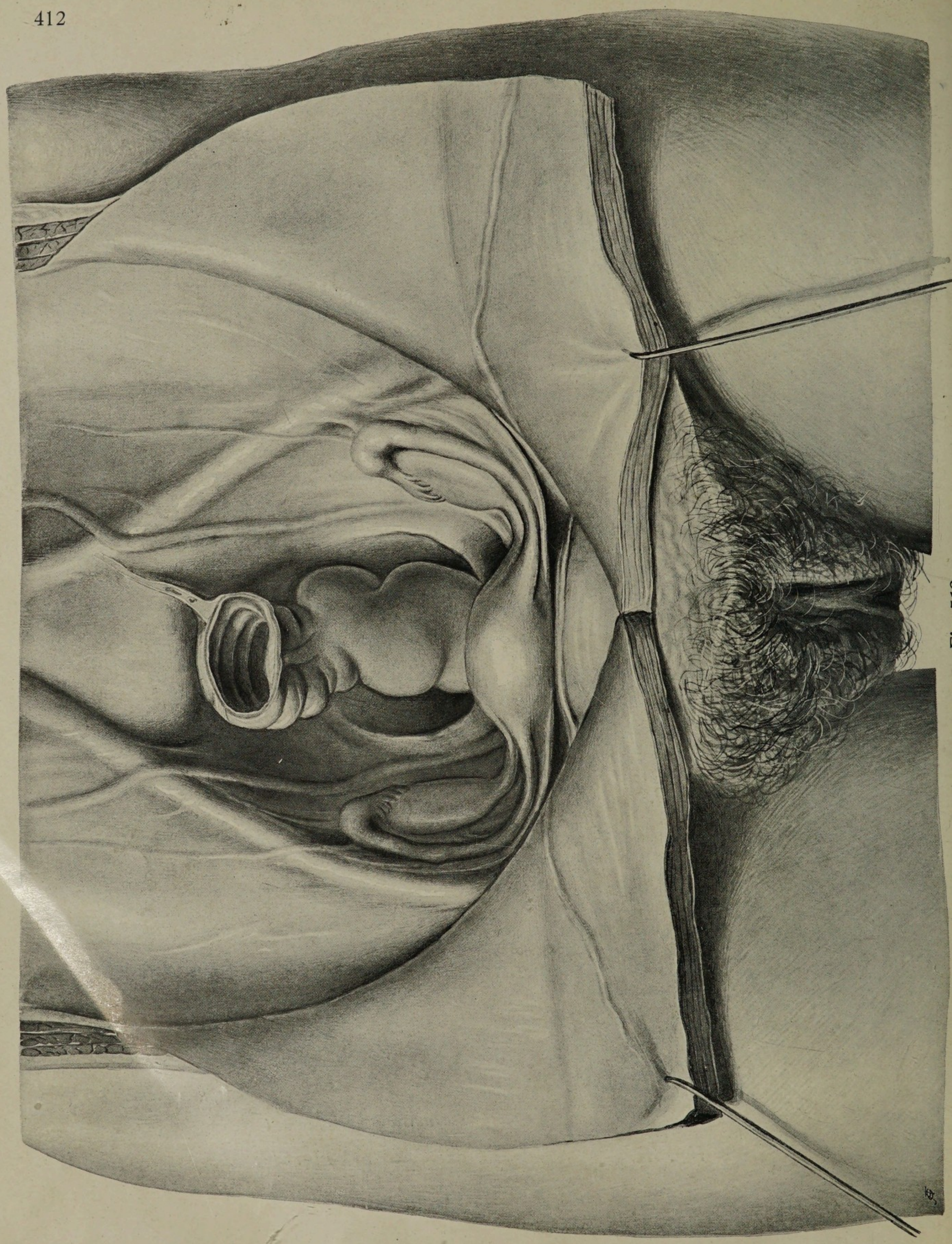


Fig. 513.

ureter dext. ... *plica recto-uterina* ... *promontorium* ... *vasa iliaca comm.* ... *mesocolon sigmoideum* ... *ureter sinister* ... *vasa sperm.* ... *excavatio rectouterina* ... *X*

The Urogenital Organs. The Female Genitalia.

Fig. 513 and 514. The female genitalia from above. ($^2/_3$)

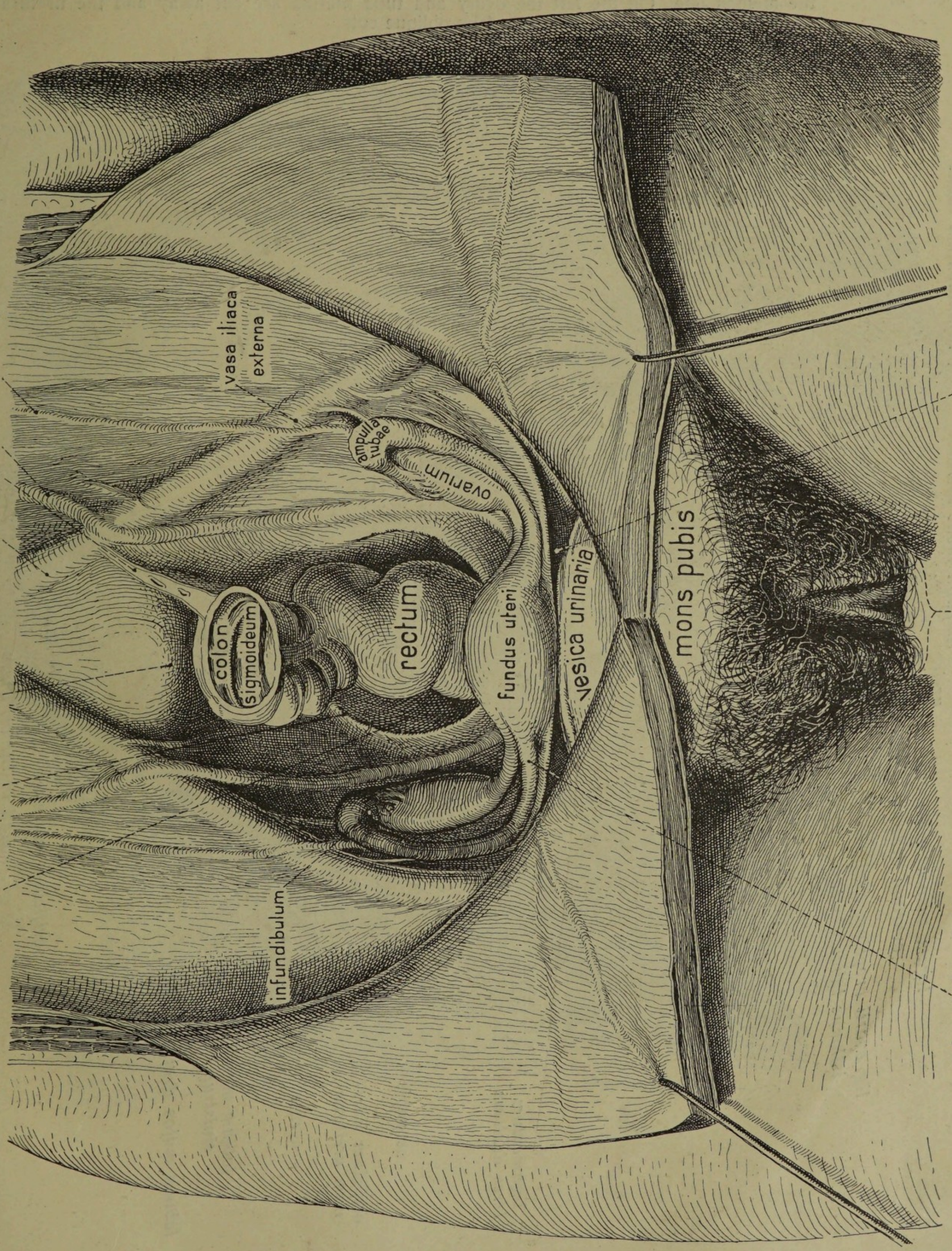


Fig. 513.

Fig. 514. *pudendum muliebre*

The Urogenital Organs. The Female Genitalia. (Cont.)

Fig. 515 and 516. The female genitalia from the left side. (2/3) The pelvis is divided near the median line. On the left the ovary and tuba uterina are cut away and the urethra and fornix of the vagina are opened by oblique cuts.

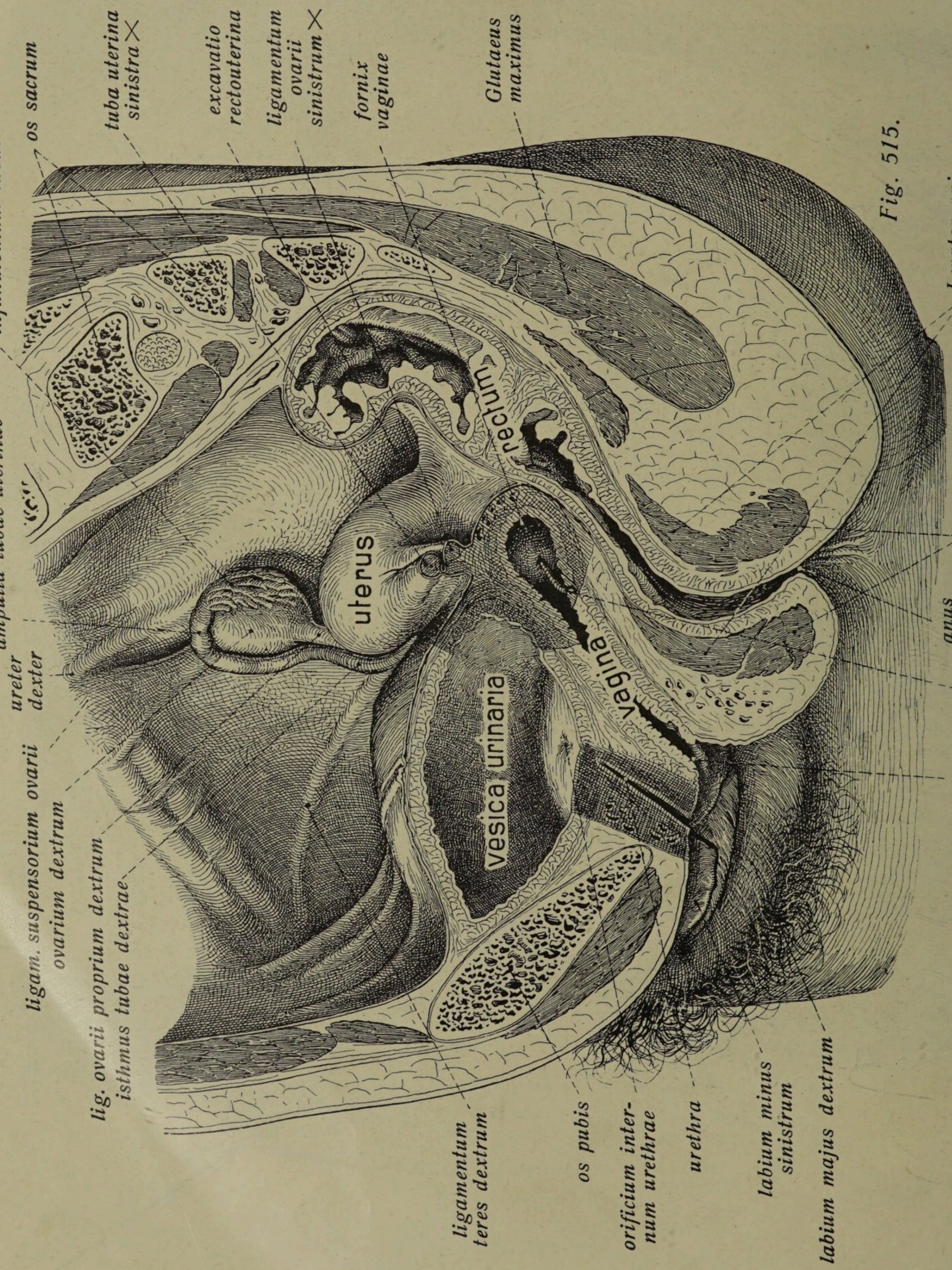


Fig. 515.

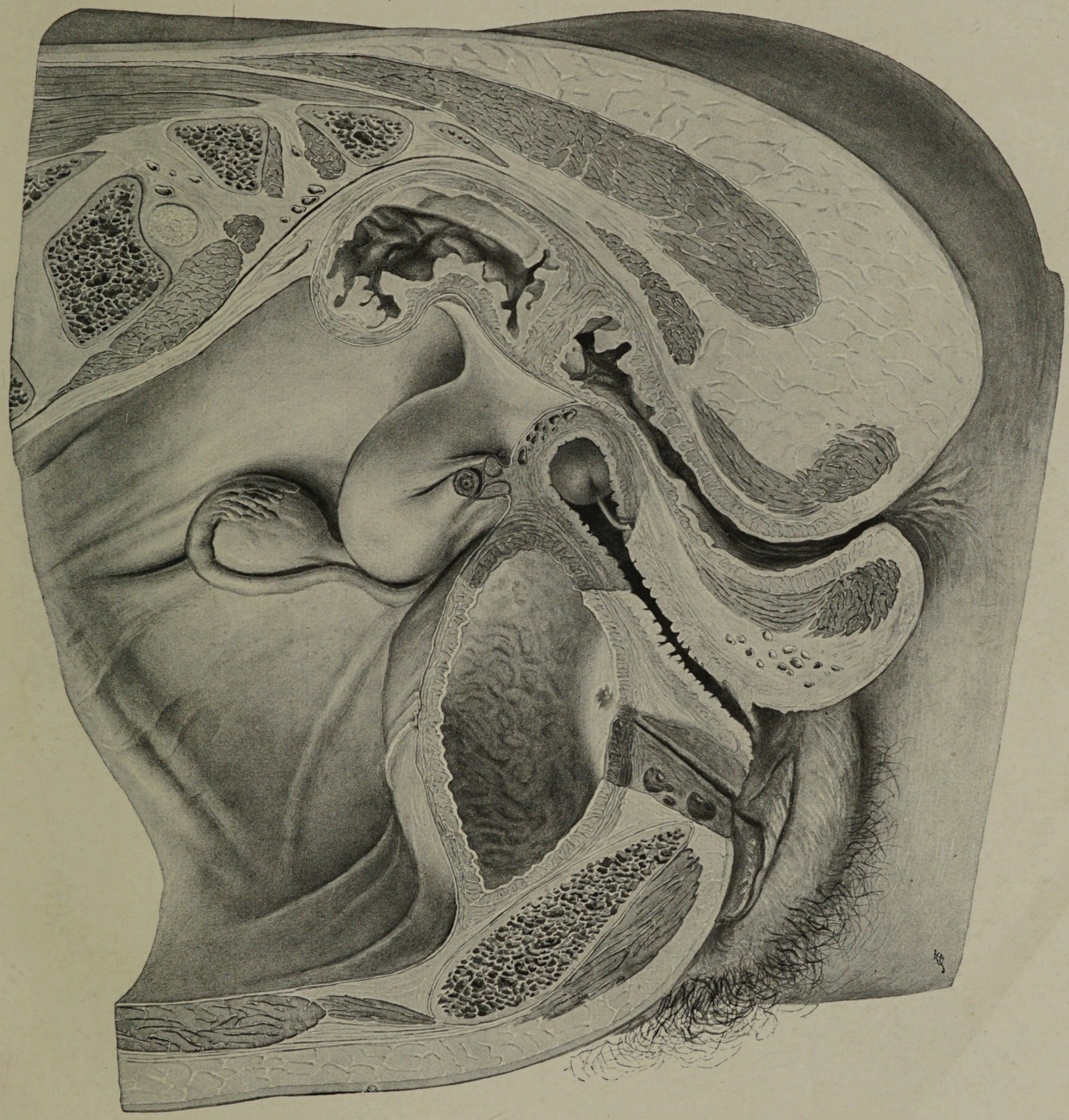


Fig. 516.

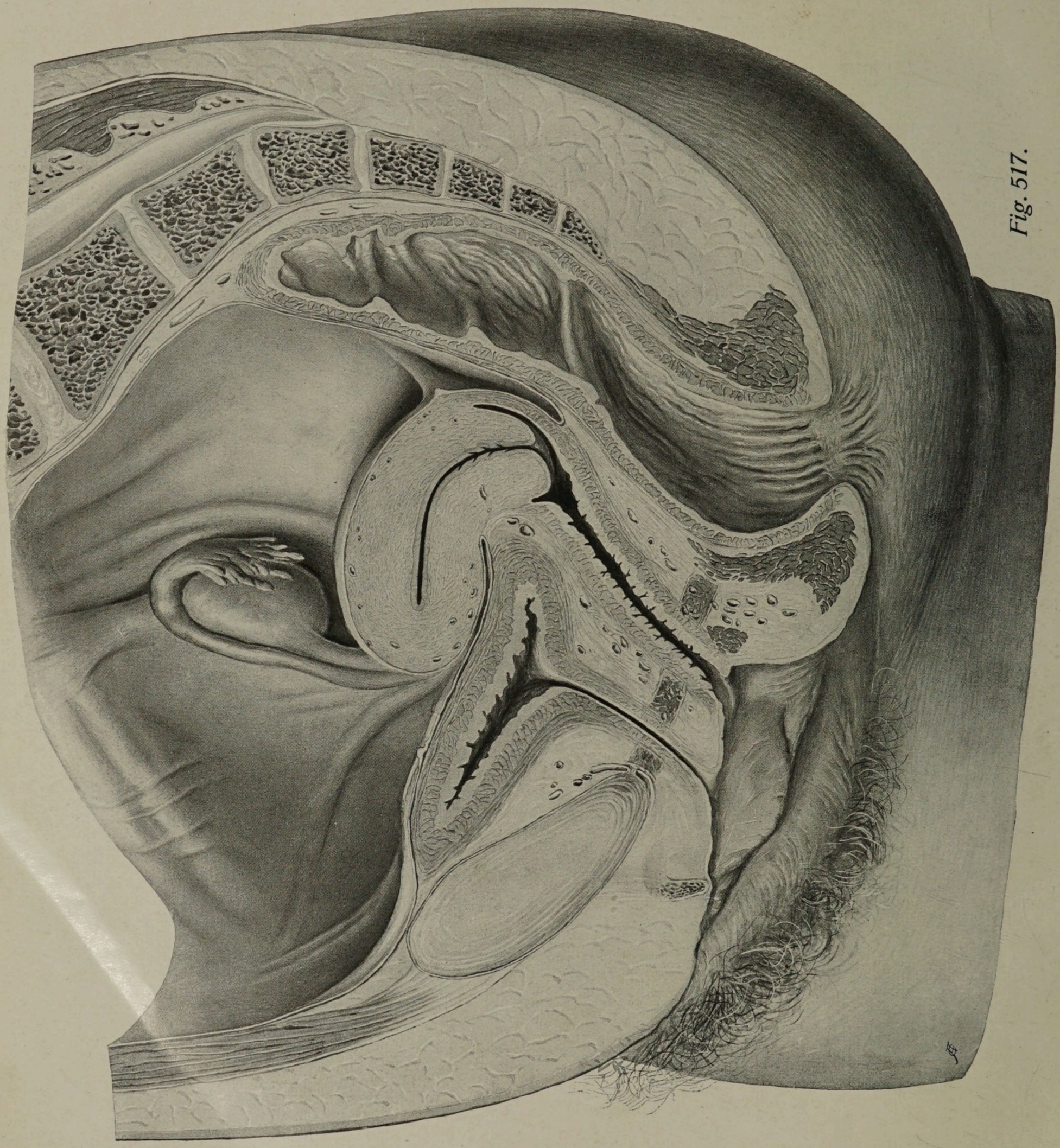

ligamentum suspensorium ovarii
ureter
infundibulum tubae
os sacrum

Fig. 517.

The Urogenital Organs. The Female Genitalia. (Cont.)

Fig. 517 and 518. Median section of the female reproductive organs. (2/3)

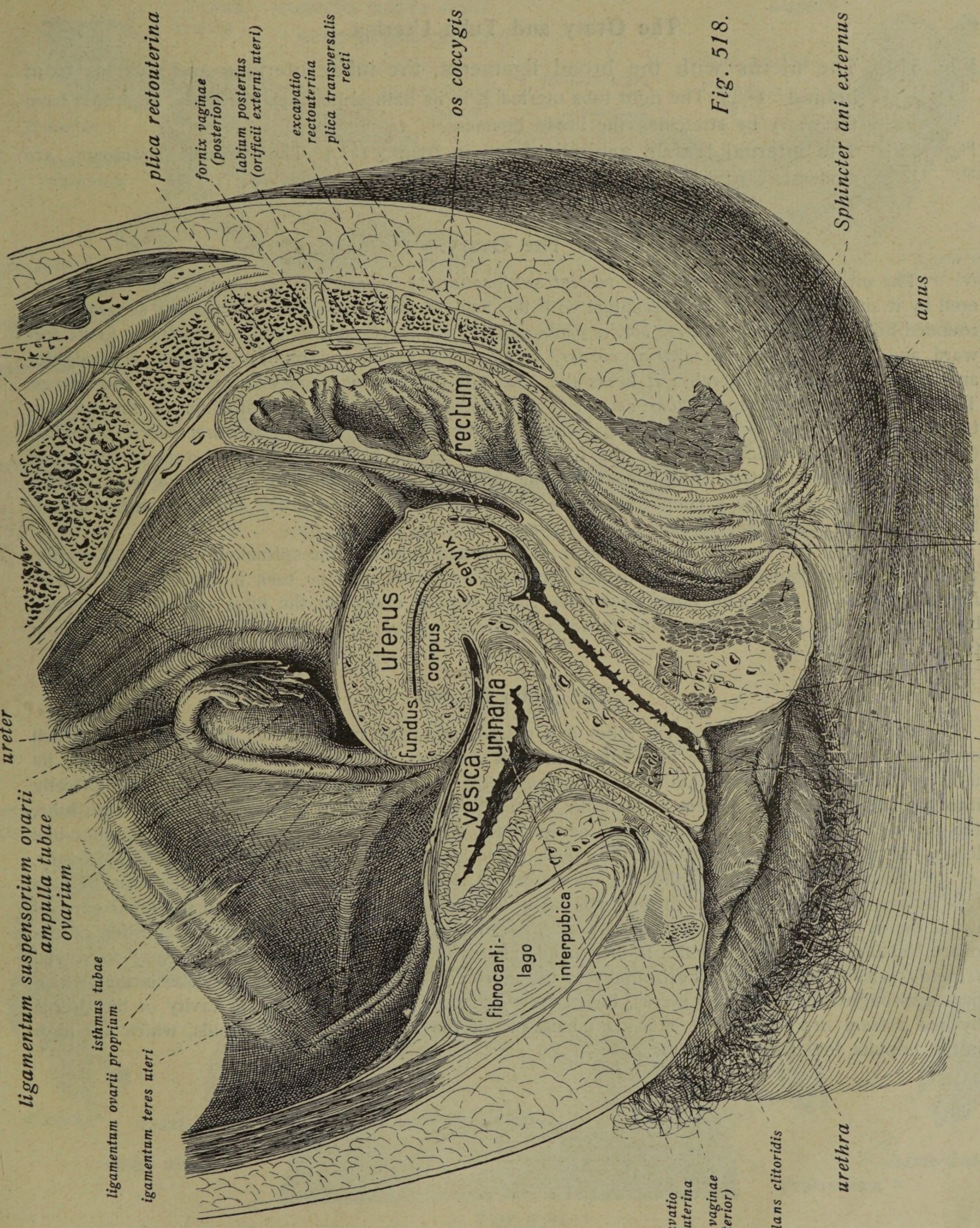


Fig. 518.

The Urogenital Organs. The Female Genitalia. (Cont.)

The Ovary and Tuba Uterina.

Fig. 519. The uterus with the broad ligaments, the tubae uterinae and ovaries from behind. ($^1/_1$) The right tuba uterina is in its natural position, the left is separated from the ovary by stretching the broad ligament.

Fig. 520. The internal female genitalia from in front. ($^1/_1$) The broad ligaments are moderately stretched and the uterus is drawn somewhat upwards.

The Ovary.

The *ovary* has two surfaces, a *medial surface* turned toward the tuba uterine and largely covered by it and a *lateral surface* in contact with the wall of the true pelvis. They are separated by rounded borders, of which the *free border (margo liber)* is more convex and broader and looks forward and medially. The *mesovarial border*, along which the mesovarium is attached, is straighter and looks forward and laterally; it bears the *hilus* for the entrance and exit of vessels and nerves. The upper, strongly rounded *tubar extremity* is directed towards the infundibulum of the tuba uterina and the lower *uterine extremity* is fastened to the uterus by the *ligamentum ovarii proprium* (ovarian ligament), which passes to the fundus of the uterus between the two layers of the broad ligament. The tubar extremity is fastened to the infundibulum of the tuba by the *fimbrica ovarica* and also to the pelvis by a connective tissue band containing muscle fibres and the ovarian vessels and nerves, *the suspensory ligament* of the ovary.

The ovary lies on the posterior layer of the broad ligament, the epithelium of which is continuous with the germinal epithelium of the ovary. Two layers may be seen in the ovary, a *medullary* and a *cortical layer*; the latter covers the entire surface except at the hilus and is characterized by containing the *ovarian* (Graafian) *follicles (folliculi vesiculosi)* or the *corpora lutea* formed from them.

The Tuba Uterina.

The *tuba uterina* (Falloppian tube) is a paired, muscular tube, 10—15 cm in length, which occupies the upper edge of the broad ligament and connects the ovary to the uterus, although its union with the ovary is only indirect. It begins at the ovary by a round orifice that opens directly into the body cavity, the *ostium abdominale*, situated at the bottom of a funnel-like part of the tube, the *infundibulum*. This is much folded on its inner surface and ends in a number of fringe-like lobes, the *fimbriae*, one of which, the *fimbria ovarica*, extends to the tubar extremity of the ovary.

The portion of the tuba following on the ostium is the *ampulla*, which is broader than the portion nearer the uterus and has strong folds in its interior. It bends sharply around the tubar extremity of the ovary and then runs almost vertically, parallel and close to the mesovarian border of the ovary, resting on the pelvic wall. It then bends almost at right angles into the greatly narrowed *isthmus*, which passes almost horizontally to the uterus. The final portion of the tuba is that which passes through the wall of the uterus, the *uterine part*, and this opens into the cavity of the uterus by the *ostium uterinum*. The mucous membrane of the tuba is raised into folds, which are high in the ampulla, lower in the isthmus.

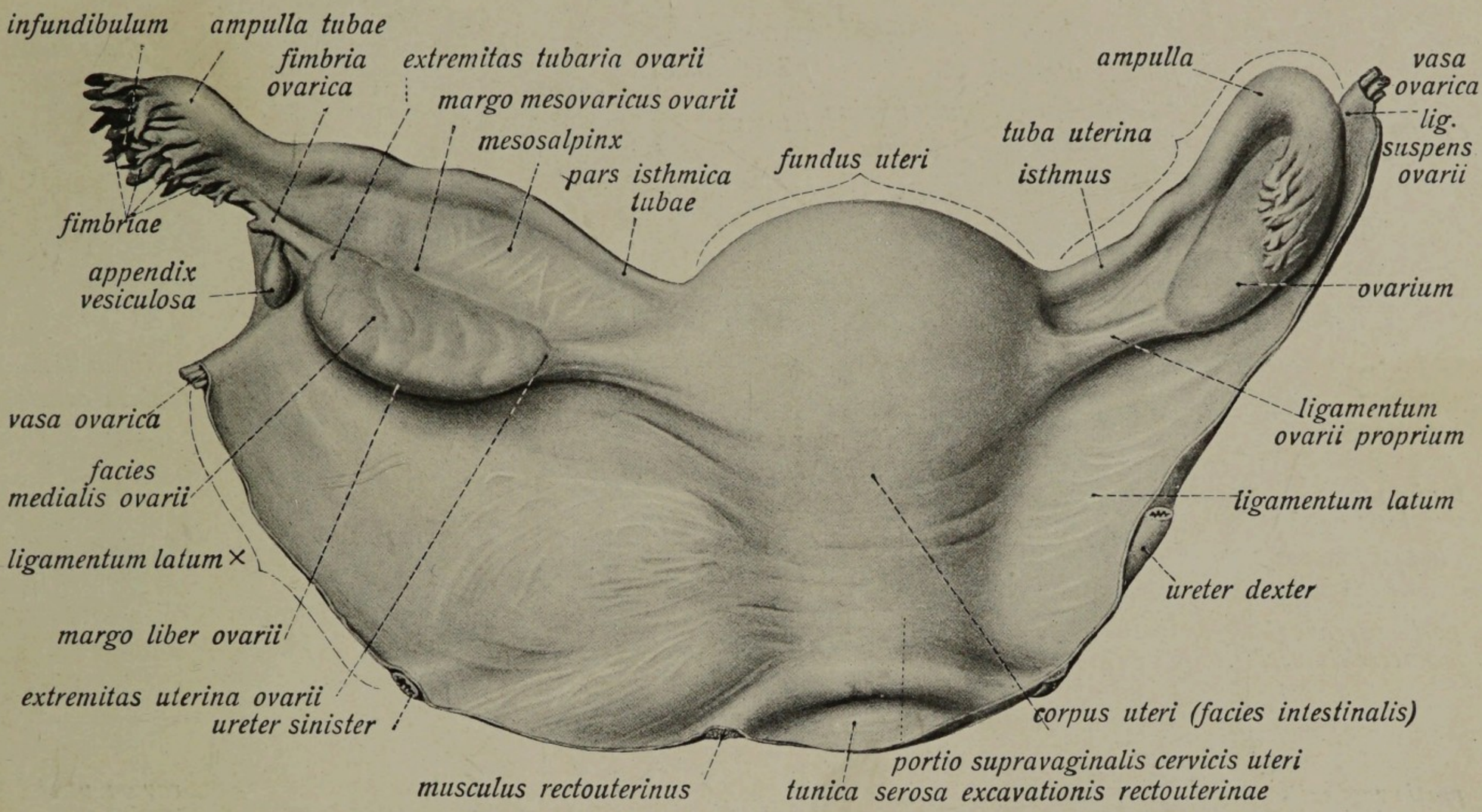


Fig. 519.

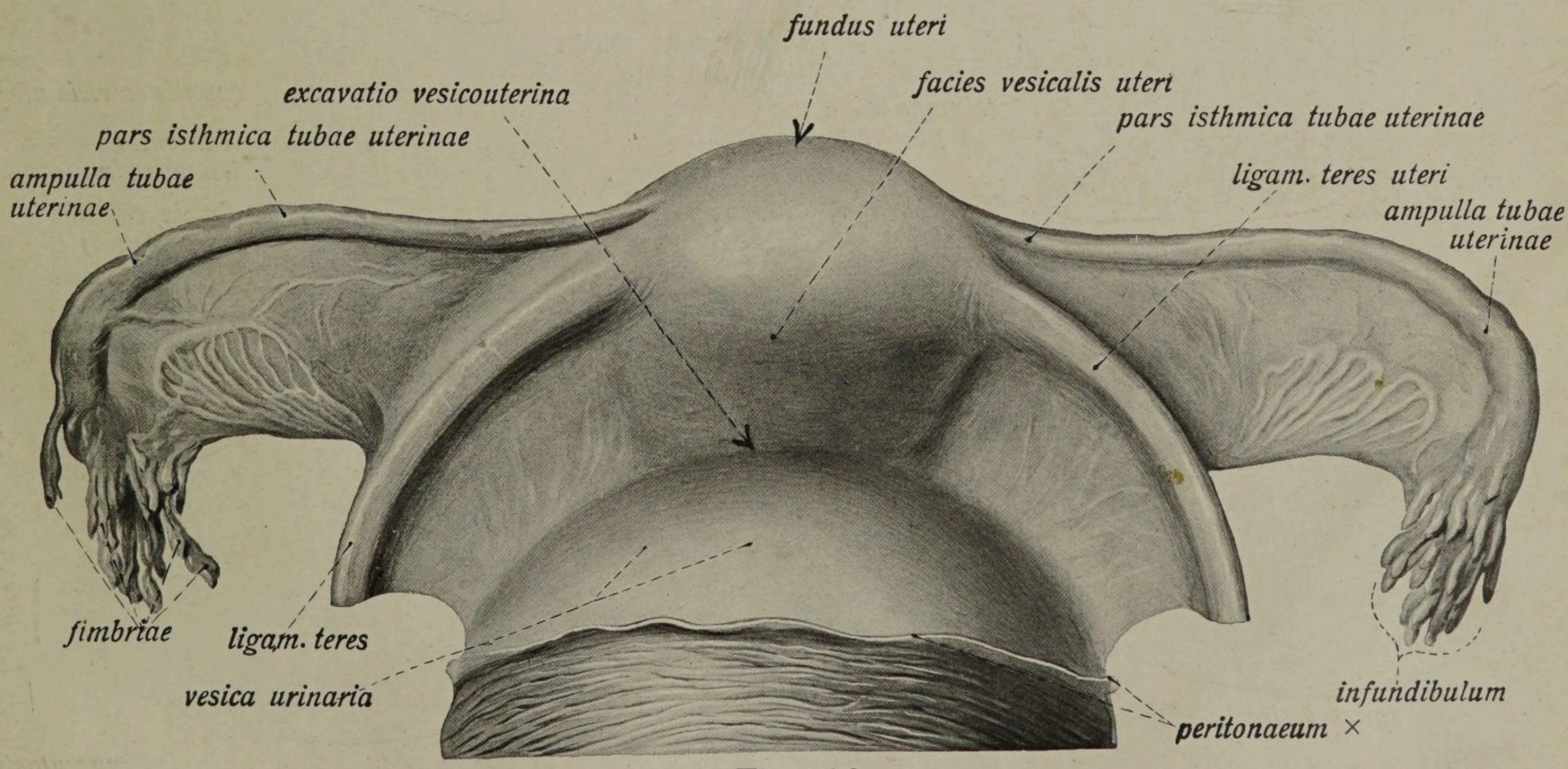


Fig. 520.

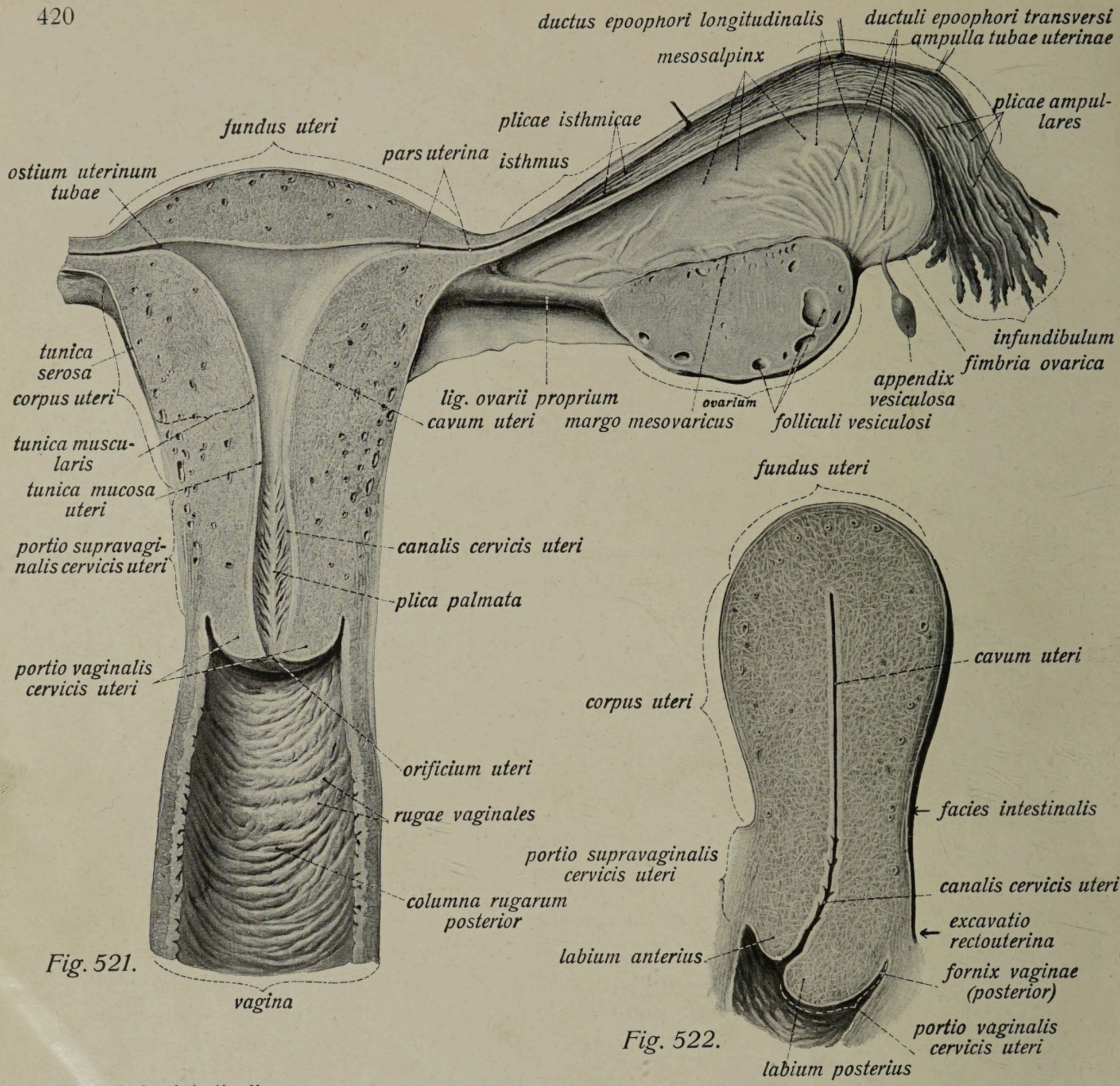


Fig. 521.

Fig. 522.

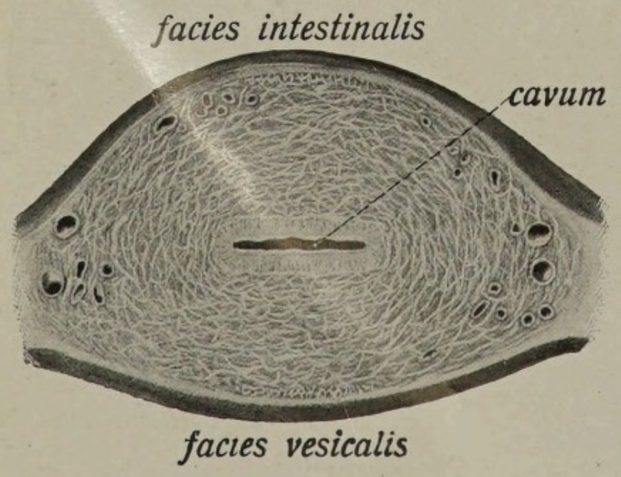


Fig. 524.

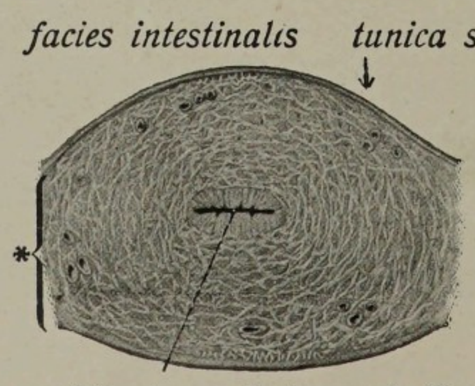


Fig. 525.

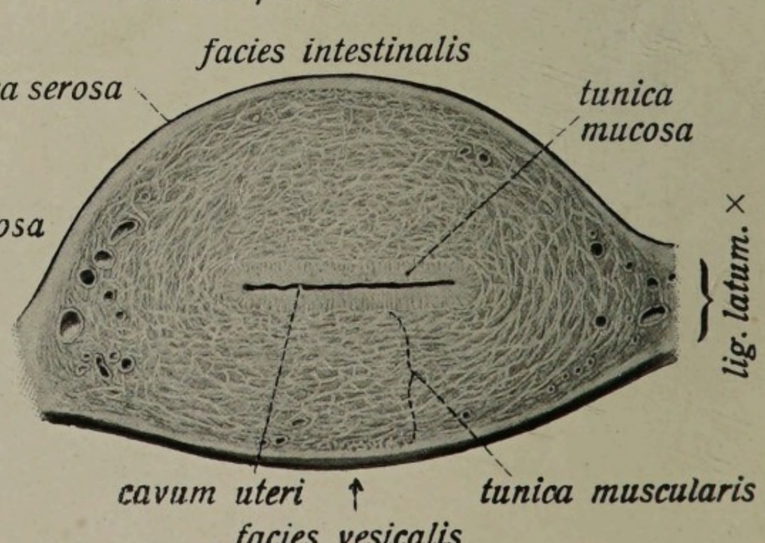


Fig. 523.

The Urogenital Organs. The Female Genitalia. (Cont.) The Uterus.

Fig. 521. A frontal section through the uterus, tuba uterina, ovary and the upper part of the vagina. ($^1/_1$) The uterus and tuba are straightened.
Fig. 522. Sagittal section of the uterus and the upper end of the vagina. ($^1/_1$)
Fig. 523—525. Transverse sections through the uterus at the level of the body, the boundary between body and cervix and the supra-vaginal portion of the cervix. ($^1/_1$) * = position of the parametrium.

The Uterus.

The uterus is a thick-walled, muscular, hollow organ that has the shape of a flattened pear. It has two principal portions, a large, upper one, the *body (corpus)*, and a smaller lower one, the *cervix*, the two being separated by a constriction, at which the uterus is bent in such a way that the body forms with the cervix an angle which is more or less marked according to the extent to which the uterus is filled. This angulation converts the vesico-uterine pouch into a mere cleft. The uppermost portion of the body that projects dome-like above the level of the tubae uterinae is termed the *fundus*. The anterior or *vesical surface* is less convex than the posterior, which is termed the *intestinal surface;* the borders are right and left. In the cervix two portions are distinguishable, a lower one which projects into the vagina, the *vaginal portion*, and an upper one above the vagina, the *supravaginal portion*. The latter is transversely elliptical in form, the former flattened cylindrical. The very thick walls of the uterus enclose a relatively small cavity, which in the body is termed the *cavity of the uterus* and in the cervix the *canal of the cervix*. The two communicate by the *internal os (orificium internum)*. The cavity of the uterus is merely a cleft, from before backwards, that is to say in the direction of the flattening of the uterus, but in the transverse direction it is more extensive. It has the form of an isosceles triangle, one angle of which is at the internal os and the other two at the ostia uterina of the tuba. The line between the two ostia is the shortest side of the triangle. The canal of the cervix on the other hand is almost cylindrical, though slightly enlarged at its middle; it begins at the internal os and opens into the vagina by the *external os* (orificium externum). Its mucous membrane is raised on both the anterior and posterior walls into a series of folds, the *plicae palmatae*. The thick, swollen lips of the external os form the vaginal portion; the *anterior lip (labium anterius)* is shorter and does not project so far as does the longer *posterior lip (labium posterius)*.

The Urogenital Organs. The Female Genitalia. (Cont.)

The Vagina.

The Vagina.

The *vagina* is a rather wide, dilatable canal, which extends from the uterus to the external genitals. In the empty condition it is strongly flattened from before backward, so that its lumen has the form of the letter H turned sidewise.

The *anterior wall* is shorter than the *posterior wall*, since the axis of the uterus is oblique to that of the vagina (anteversio uteri), and the vaginal portion of the uterus projects into the vagina in such a way that its two lips are of different lengths. The anterior wall of the vagina is attached to the base of the short anterior lip, the posterior to that of the longer posterior lip, so that the wall of the vagina is firmly united to that of the uterus and the vaginal mucous membrane passes directly into that of the uterine lips. There is thus formed a small, circular space between the uterine lips and the vaginal wall, the *fornix vaginae*; it is much deeper behind than at the sides or especially in front. On the anterior as well as the posterior wall there is a system of arched, transverse folds, the *rugae*, which form in the middle line of each wall a longitudinal ridge, the *columna rugarum*. The lower part of the anterior columna is especially prominent, this being due to the urethra, which bulges forward the vaginal wall as the *urethral carina* and is visible even in the vestibule. The mucous membrane of the vaginal portion of the uterus is entirely free from folds.

The *bulbus vestibuli* is an erectile body, homologous with the bulb of the corpus cavernosum urethrae of the male, and consists of two almost completely separated portions. They are situated one on either side of the orifice of the vagina and are elongated bodies, rounded and thickened posteriorly and flattened on the sides. Anteriorly they become smaller and are connected by a venous plexus, placed between the urethral and vaginal orifices. The two bulbi together form, therefore, a horse-shoe-shaped structure open posteriorly towards the orifice of the vagina.

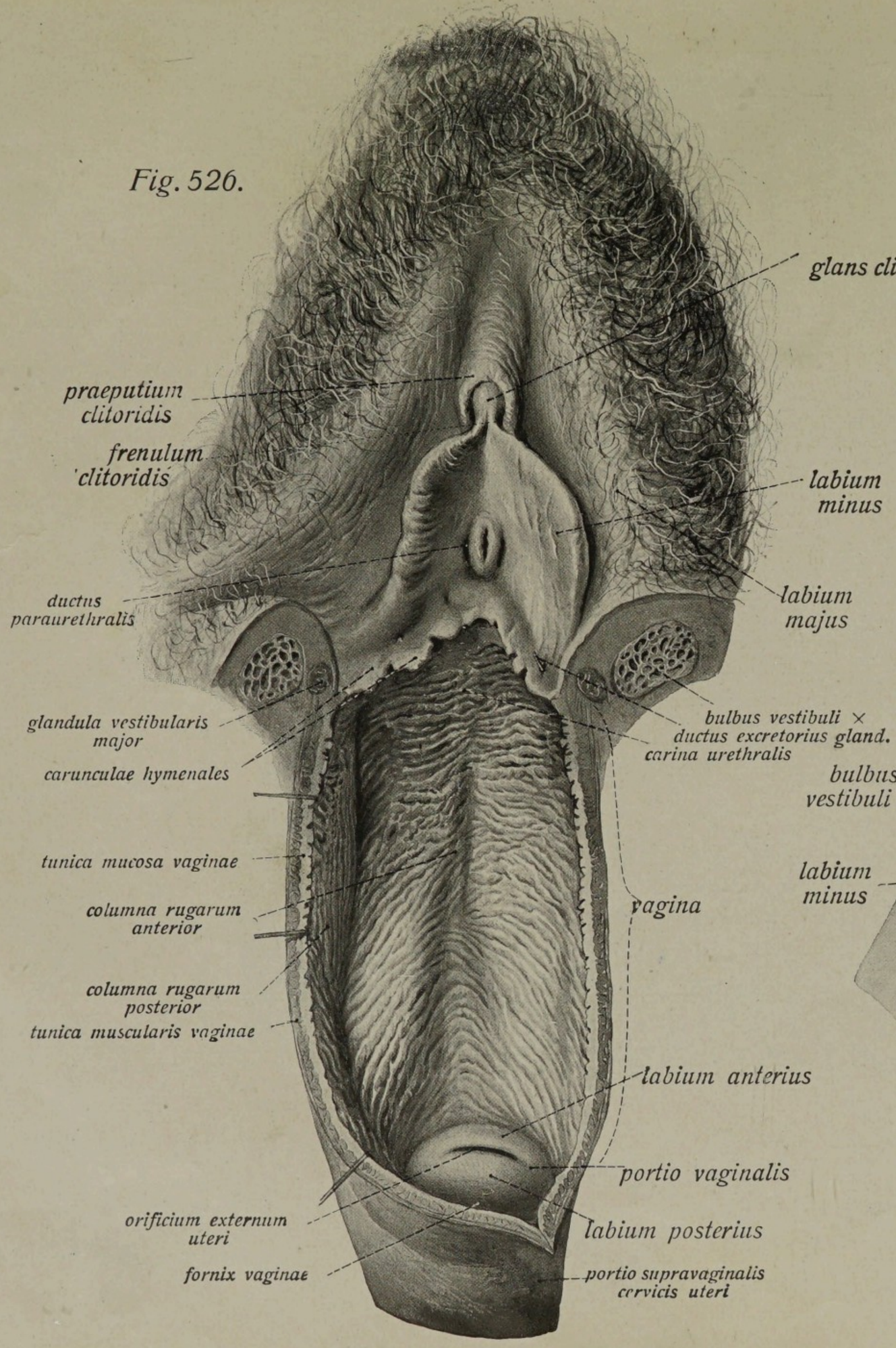
In the region of the vestibule there are also the paired *greater vestibular glands* (glands of Bartholin). They open close to the lateral margins of the orifice of the vagina at about the level between their posterior and middle thirds, just at the junction of the skin of the vestibule with the mucous membrane of the vagina; when the hymen is present the openings lie in front of it.

Fig. 526. The vagina and the external genitalia of a woman who had borne children. ($^1/_1$) The vagina is opened on its lateral surface.

Fig. 527. The erectile organs of the female urogenital sinus and the greater vestibular glands. ($^1/_1$) The Bulbocavernosus is for the most part removed; the labia minora are retained up to the clitoris.

cavernosus is for the most part removed; the labia minora are retained up to the clitoris.

Fig. 526.



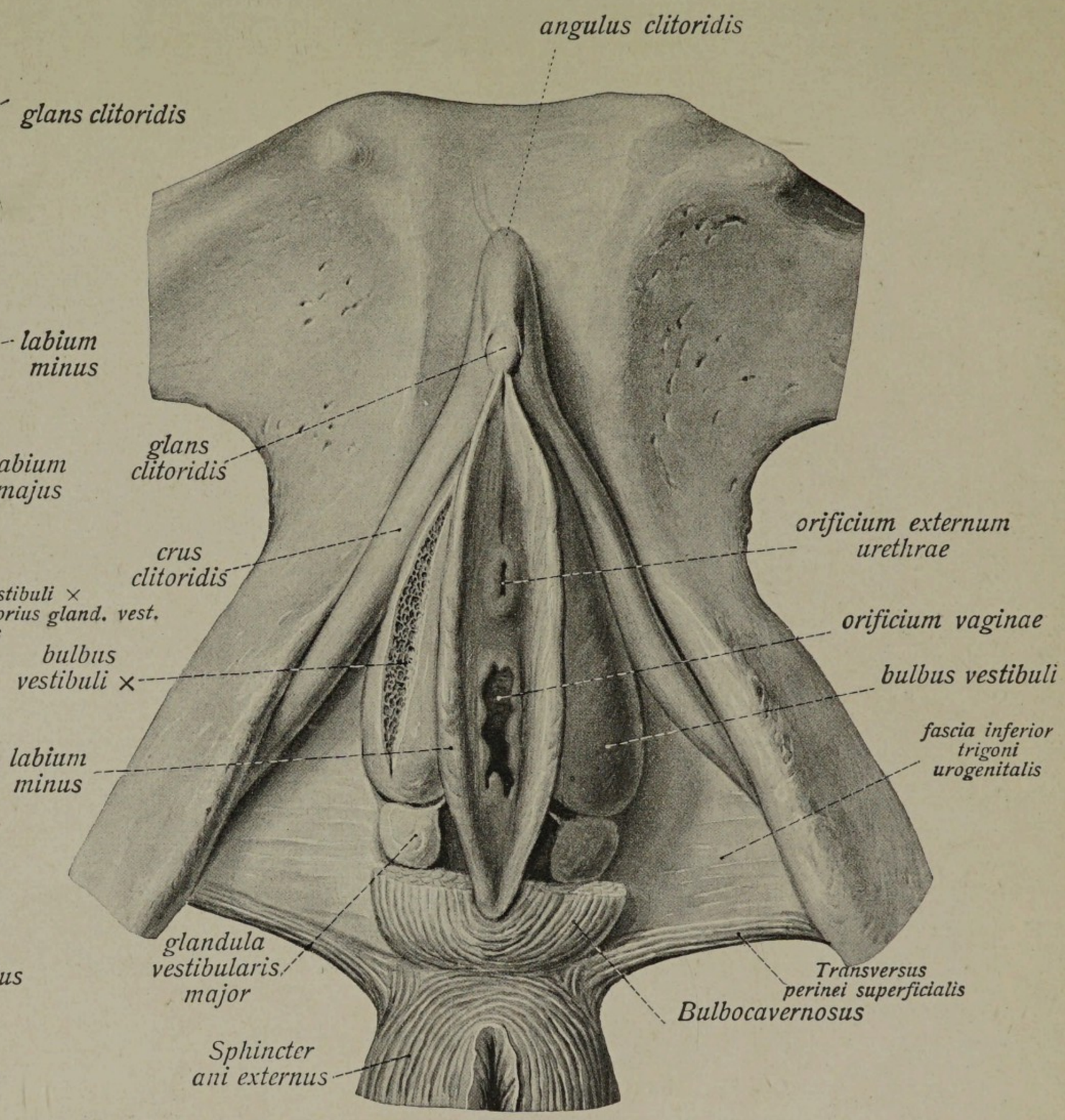


Fig. 527.

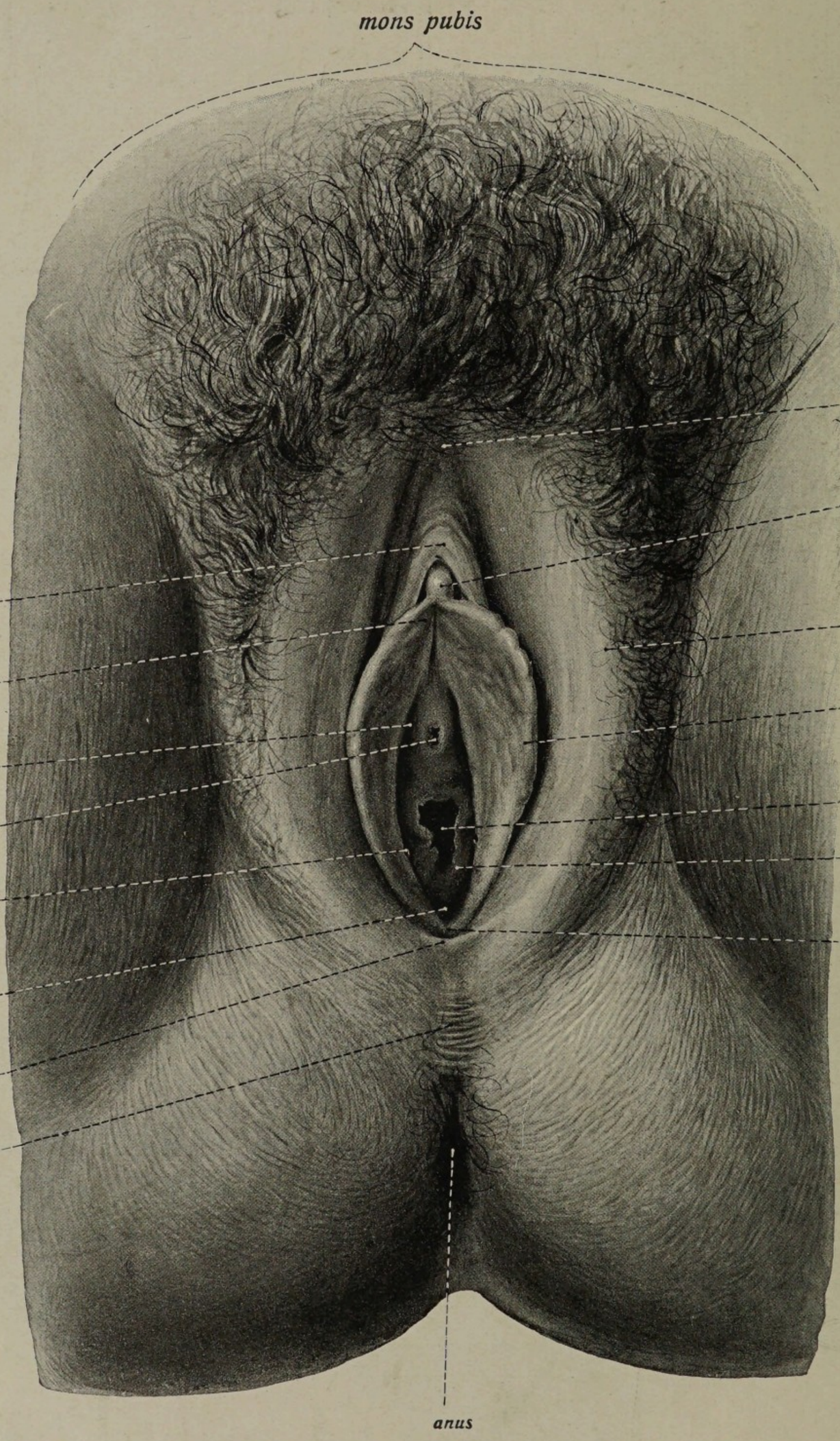

mons pubis
commissura labiorum anterior
glans clitoridis
praeputium clitoridis
labium majus
frenulum clitoridis
labium minus
ductus paraurethralis
orificium vaginae
orificium urethrae externum
hymen femintnus
ductus excretorius glandulae vestibularis majoris
frenulum labiorum pudendi
fossa navicularis
commissura labiorum posterior
perineum
anus

Fig. 528.

The Urogenital Organs. The Female Genitalia. (Cont.) The Vulva.

Fig. 528. The vulva of an 18-year old virgin. ($^4/_5$)

The Vulva.

The entrance to the *vulva* is a median cleft, the *rima pudendi*, bounded laterally by strong cutaneous folds, rich in fatty tissue, the *labia majora*, which are connected anteriorly and posteriorly by the low *anterior* and *posterior commissures*. Above the rima is the *mons pubis*, due to an accumulation of fatty tissue in the skin. The outer surfaces of the labia majora have the usual characters of the skin, contain numerous sebaceous glands and strong hairs; the inner surfaces are more like mucous membrane. The ligamenta teretia of the uterus end in their fatty tissue.

The *labia minora* are also cutaneous folds like the labia majora, but are as a rule much shorter, smaller and thinner; they are placed parallel to the labia majora and medial to them. Usually their greatest height is near their anterior ends; posteriorly they become much lower and lose themselves in the *frenulum*, in front of the posterior commissure. They are destitute of hairs and of fat tissue, but, on the other hand, they are richly supplied with sebaceous glands.

The area bounded by the labia minora is termed the *vestibule*. In its anterior portion is the *clitoris*, which in its position and structure resembles the penis of the male, but differs in being much smaller and in not being traversed by the urethra. It has two *crura* arising from the ischia, a *body (corpus)* and a *glans*, and contains two small elongated erectile bodies, the *corpora cavernosa clitoridis*. Only the slightly thickened, rounded, anterior end of the clitoris, the *glans clitoridis*, projects sufficiently into the vestibule that the labia minora can unite in front of the glans to form a *praeputium clitoridis*, while behind the glans they form a low transverse fold, the *frenulum clitoridis*.

Immediately behind and below the frenulum there is the *external orifice of the urethra* and on this follows, in the most posterior part of the vestibule, the *orifice of the vagina*. Associated with this in virgins is a usually semilunar membrane, the *hymen*, arising from the posterior wall of the vagina. After parturition has taken place it is represented by irregular, often notched, scarred lobes or warts, the *carunculae hymenales (myrtiformes)*.

The Perineal Muscles.

Fig. 529. The perineal muscles of the male from the left side after removing the bladder and rectum. ($^2/_3$) The preparation is as in Fig. 505.

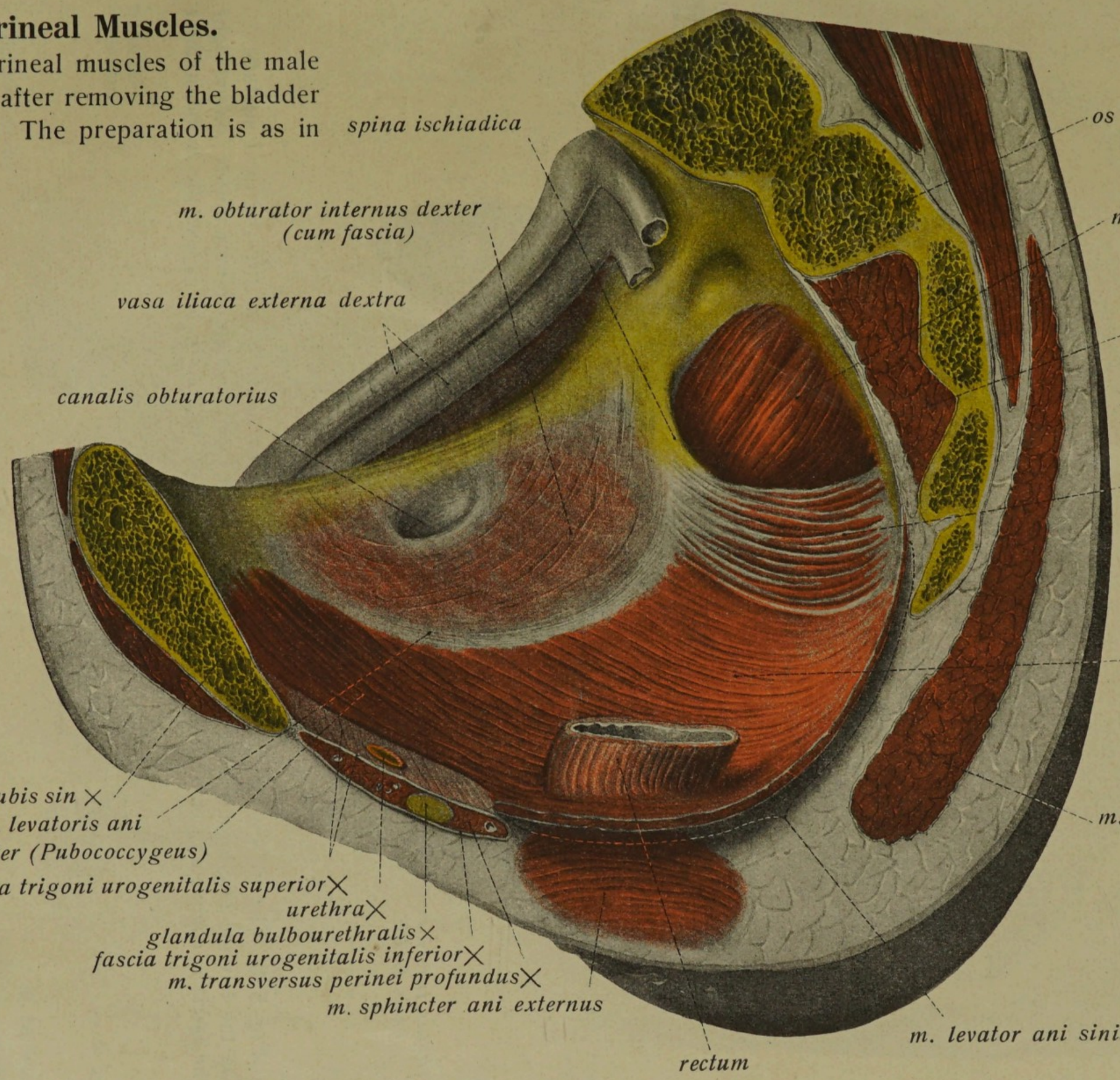


Fig. 529.

The Perineal Muscles and Fasciae. (Cont.)

Plate 17.

The superficial layer of muscles of the female perineum. ($^2/_3$) On the right the Bulbo-cavernosus is entirely, on the left only partly exposed. The Ischio-cavernosus is exposed only on the right.

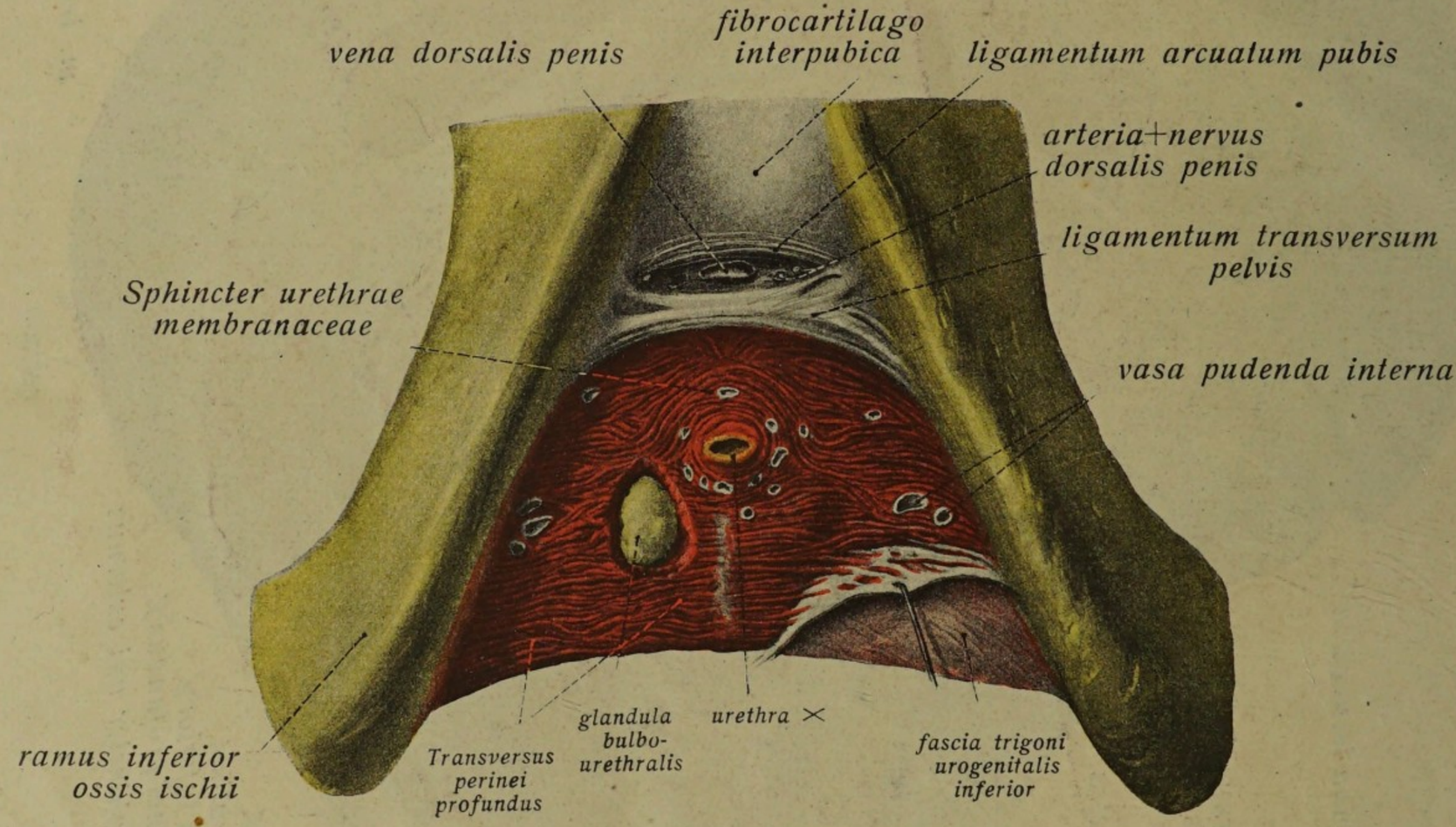
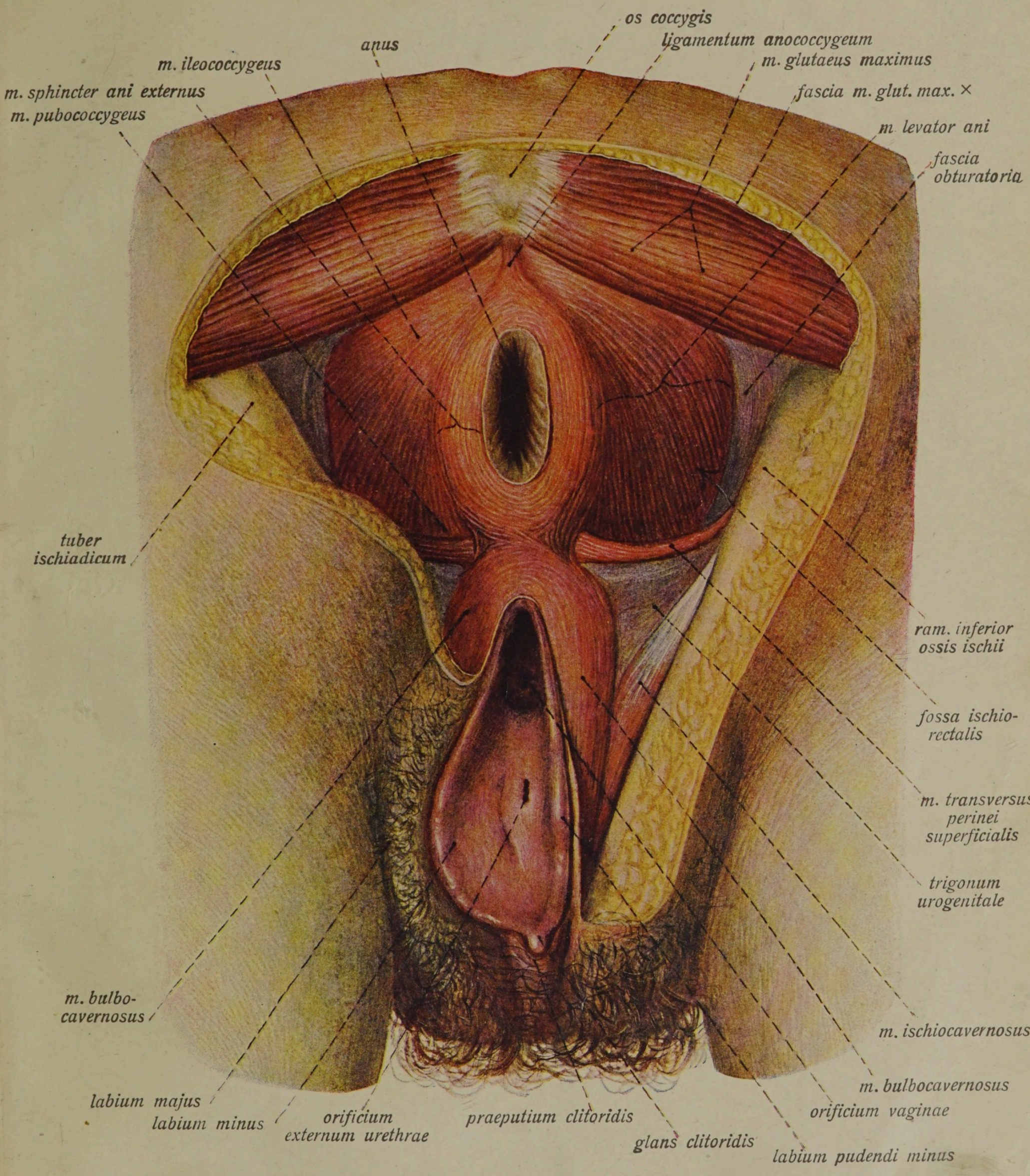


Fig. 530.

Fig. 530. The urogenital trigone (diaphragm) of the male from the perineal surface. On the left the inferior fascia is partly retained to show its connection with the muscle; on the right the fascia is completely removed and the muscle cut away sufficiently to expose the bulbo-urethral gland.


os coccygis
ligamentum anococcygeum
anus
m. ileococcygeus
m. glutaeus maximus
m. sphincter ani externus
fascia m. glut. max.
m. pubococcygeus
m. levator ani
fascia obturatoria
tuber ischiadicum
ram. inferior ossis ischii
fossa ischio-rectalis
m. transversus perinei superficialis
trigonum urogenitale
m. bulbo-cavernosus
m. ischiocavernosus
m. bulbocavernosus
labium majus
labium minus
orificium externum urethrae
praeputium clitoridis
orificium vaginae
glans clitoridis
labium pudendi minus

Angiology.

The Circulation of the Blood.

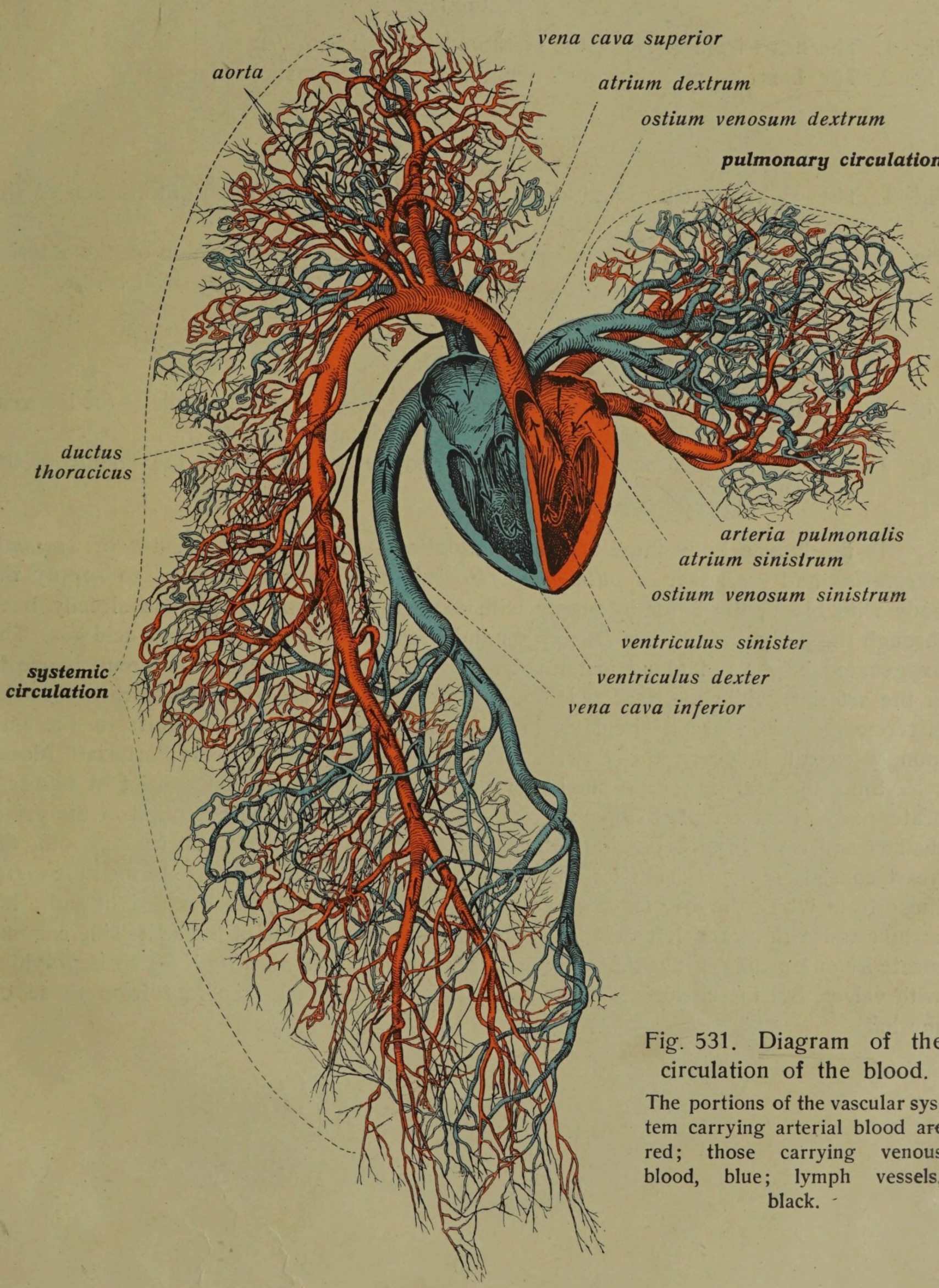


Fig. 531. Diagram of the circulation of the blood.

The portions of the vascular system carrying arterial blood are red; those carrying venous blood, blue; lymph vessels, black.

The Heart.

Plate 18.

Fig. 1. The heart from in front, the sterno-costal surface. ($^4/_5$)
Fig. 2. The heart from below and behind, the diaphragmatic surface. ($^4/_5$)

Plate 19.

Fig. 1. The right ventricle and right atrium opened from the right border of the heart. ($^4/_5$)
Fig. 2. The right ventricle and pulmonary artery opened by an incision on the anterior surface and along the right border of the heart. ($^4/_5$) * = the right border.

Plate 20.

Fig. 1. The left ventricle and aorta opened by an incision at the middle of the left ventricle and another along the anterior longitudinal groove. ($^4/_5$)
Fig. 2. The left ventricle and left atrium opened by an incision at the middle of the ventricle. ($^4/_5$)

In the human body there are two circulations, the so-called greater or *systemic circulation* and the lesser or *pulmonary circulation*. The former serves to supply the body with blood, the latter to supply with oxygen the blood which has already been through the body and has lost its oxygen and become laden with carbonic acid gas. The oxygenated bright red blood is termed *arterial*, since in the systemic circuit it occurs in the arteries, while the dark red blood, poor in oxygen and abundant in carbonic acid, is termed *venous*, since it circulates in the veins of the systemic circuit. In the pulmonary circuit, however, the arteries contain "venous" and the veins "arterial" blood.

Since the heart is the propulsive organ for both circuits it must consist of two separate parts. Furthermore, since special chambers occur for the reception of the veins, distinct and capable of being shut off from those from which the arteries pass out, the heart consists of four chambers. Those into which the veins open are termed the *atria*, those from which the arteries arise are termed the *ventricles*. There is a right and a left atrium and a right and left ventricle. The atrium and ventricle of the same side communicate by an opening, the *ostium venosum (atrio-ventricular opening)*, which is provided with valves, but the chambers of the right sides are perfectly separate from those on the left.

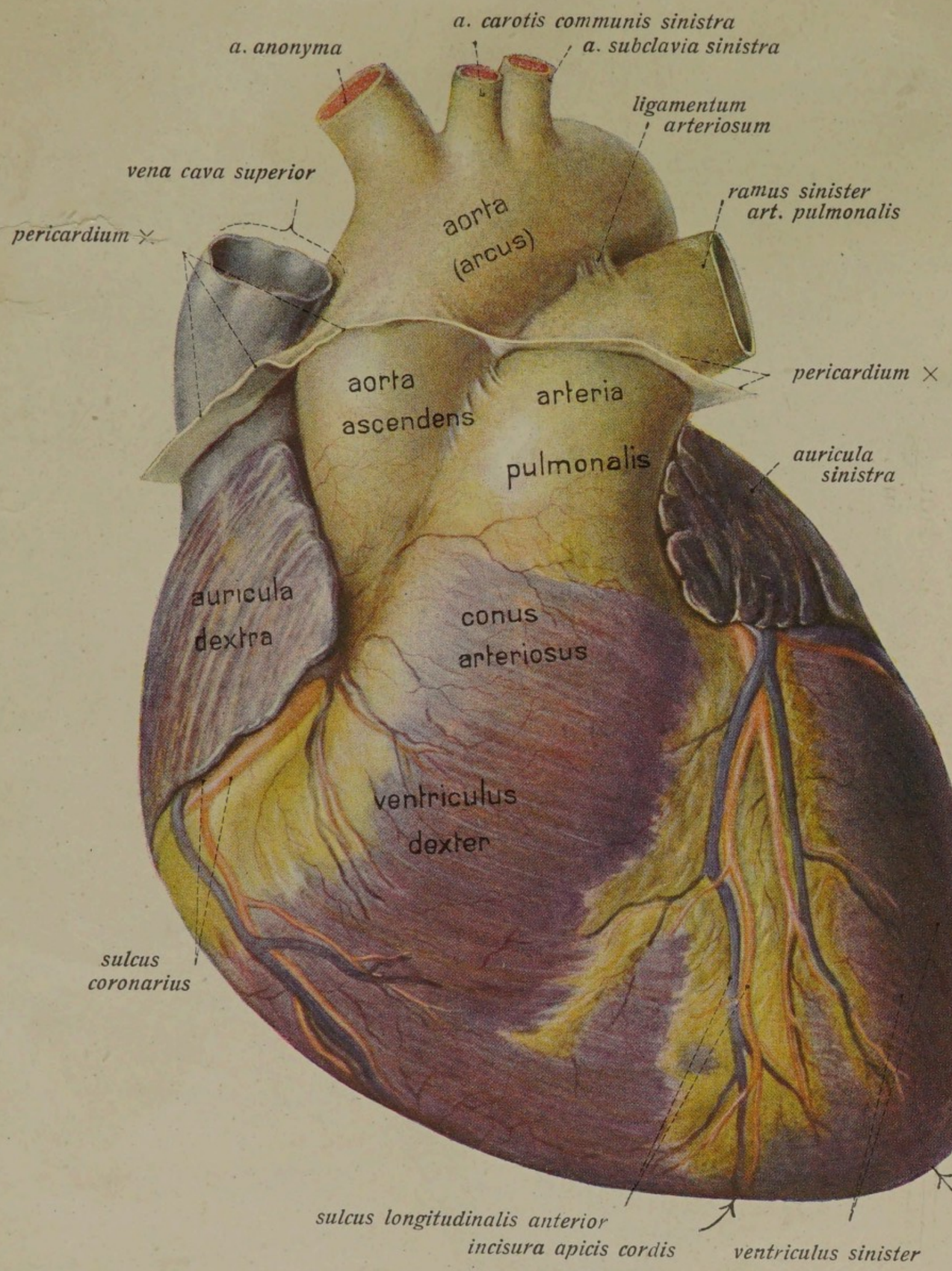


Fig. 1.

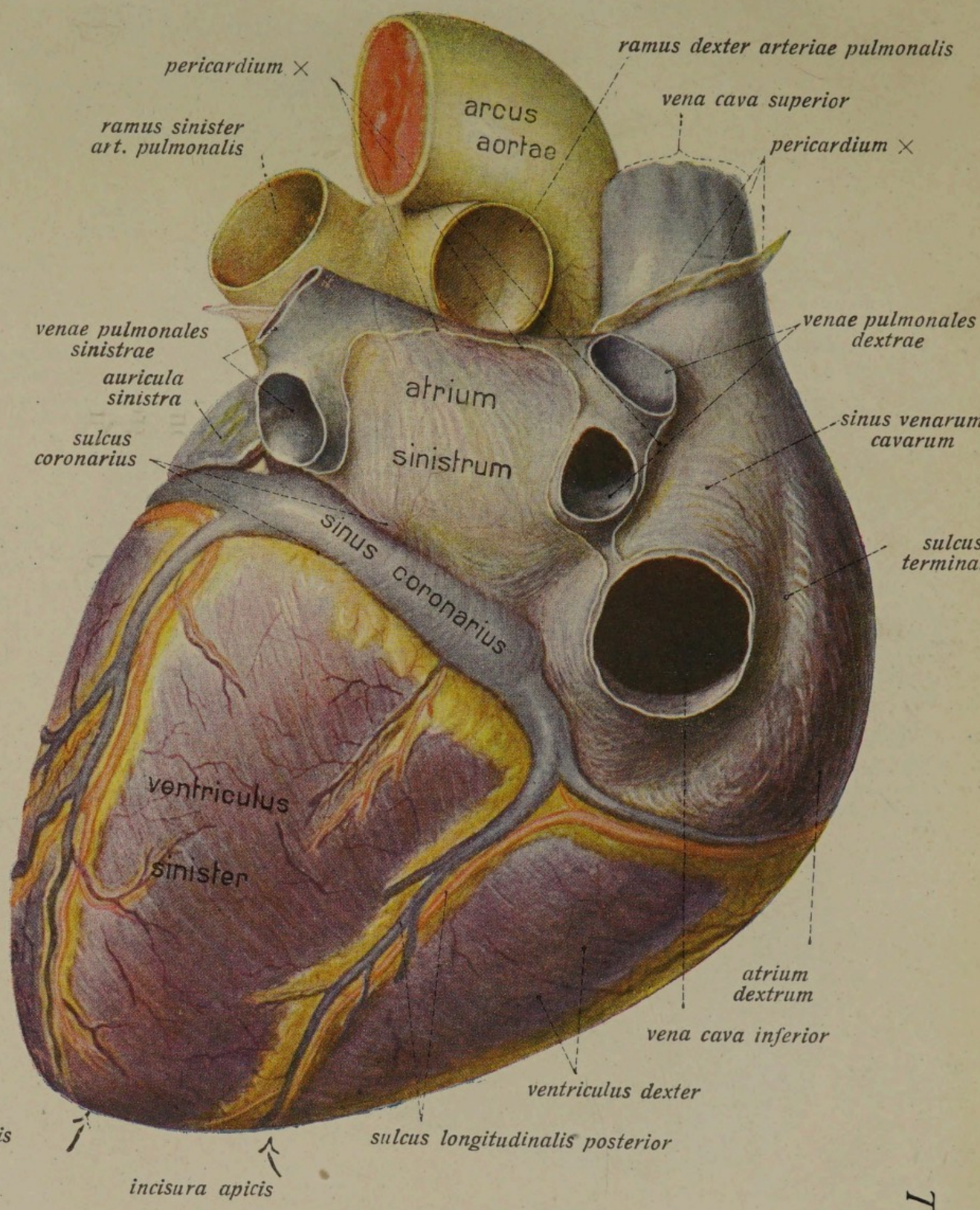
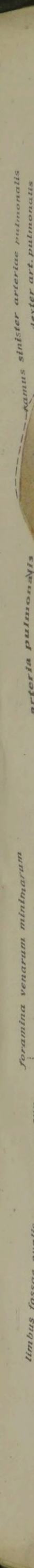


Fig. 2.

Tab. 18.


Ramus sinister arteriae pulmonalis
dexter art. pulmonalis
foramina venarum minimarum
limbus fossae ovalis

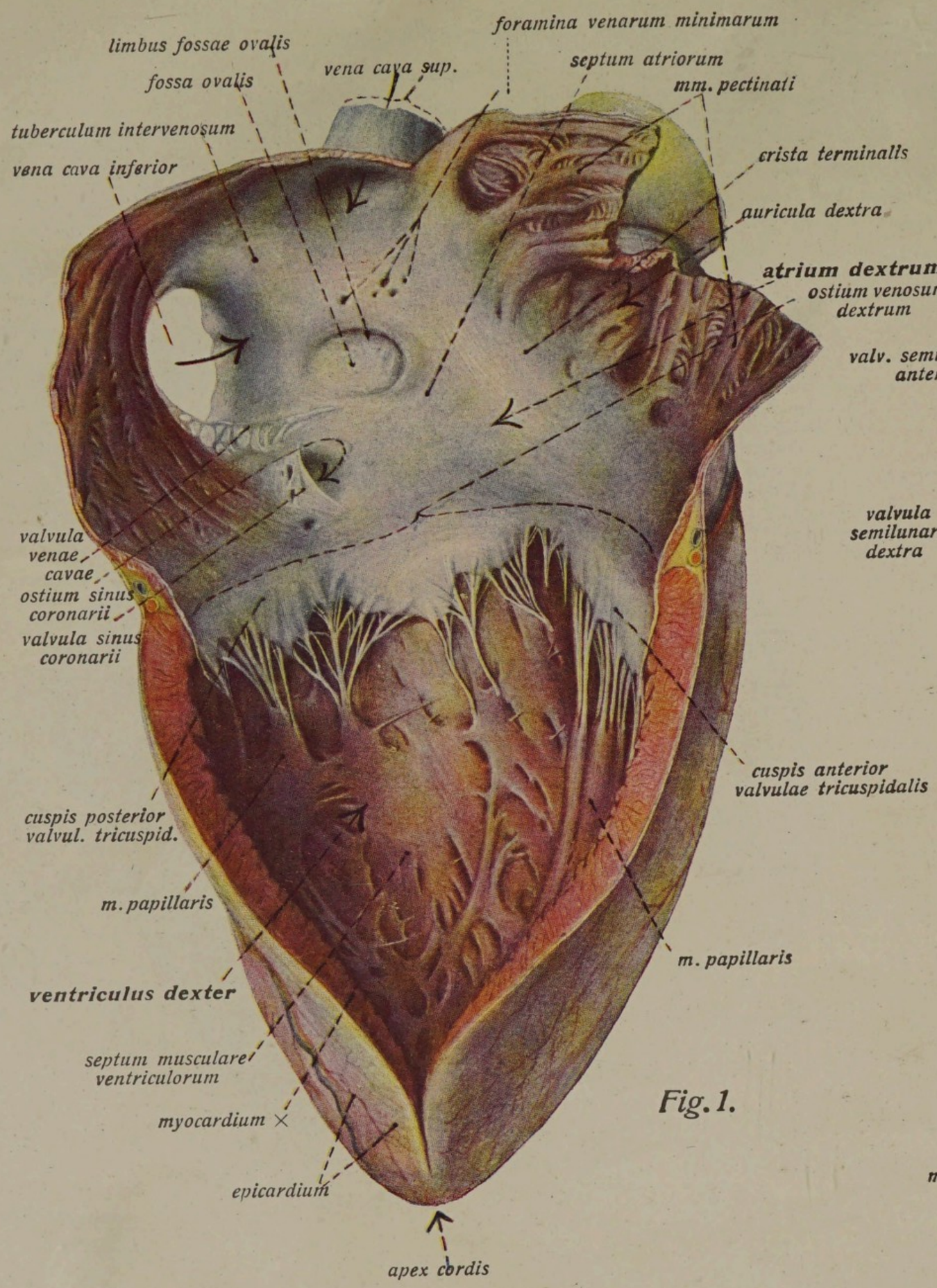


Fig. 1.

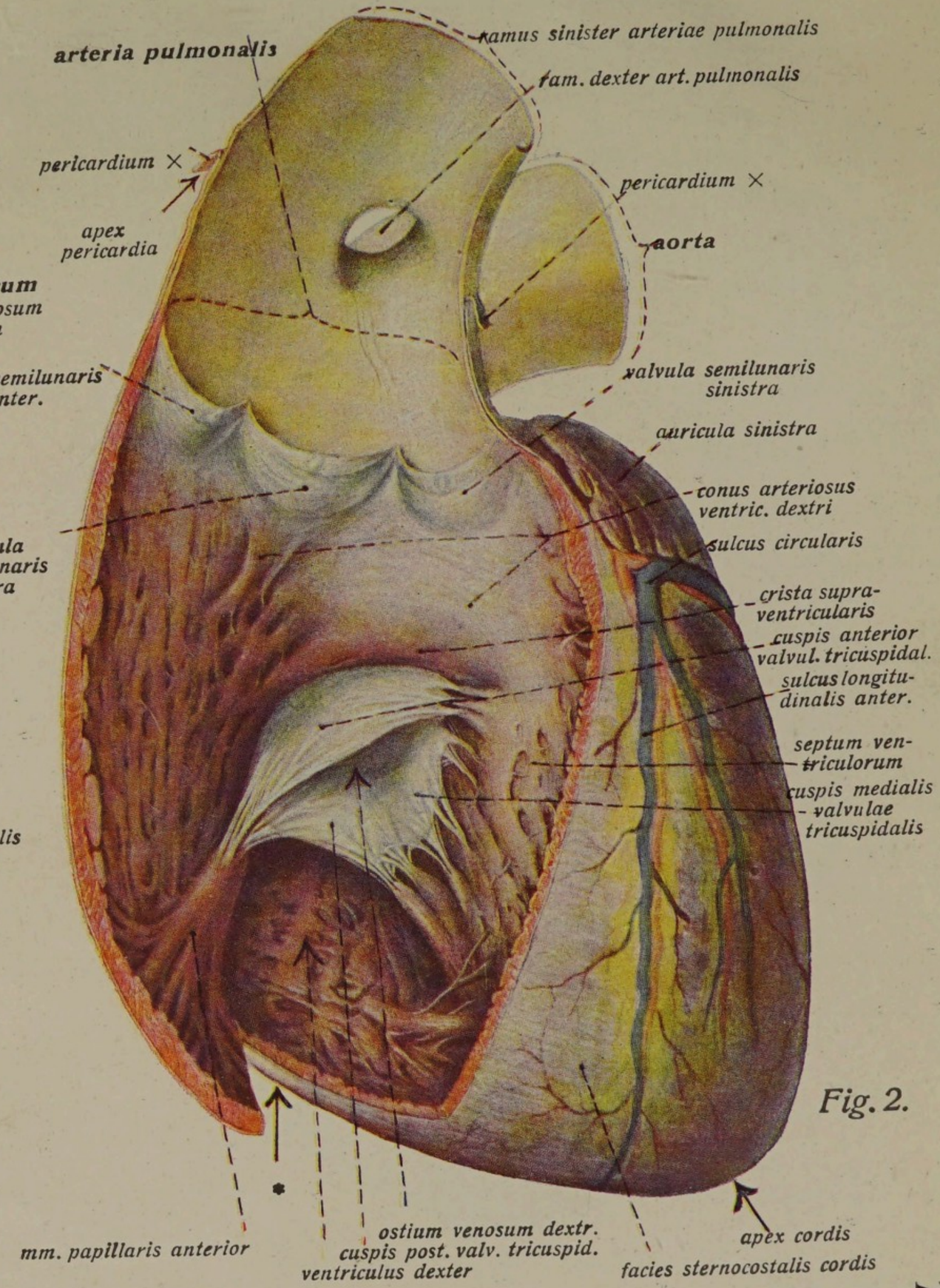


Fig. 2.

Tab. 19.

auris posterior valvulae bicuspidalis ×

auris ad auriculam

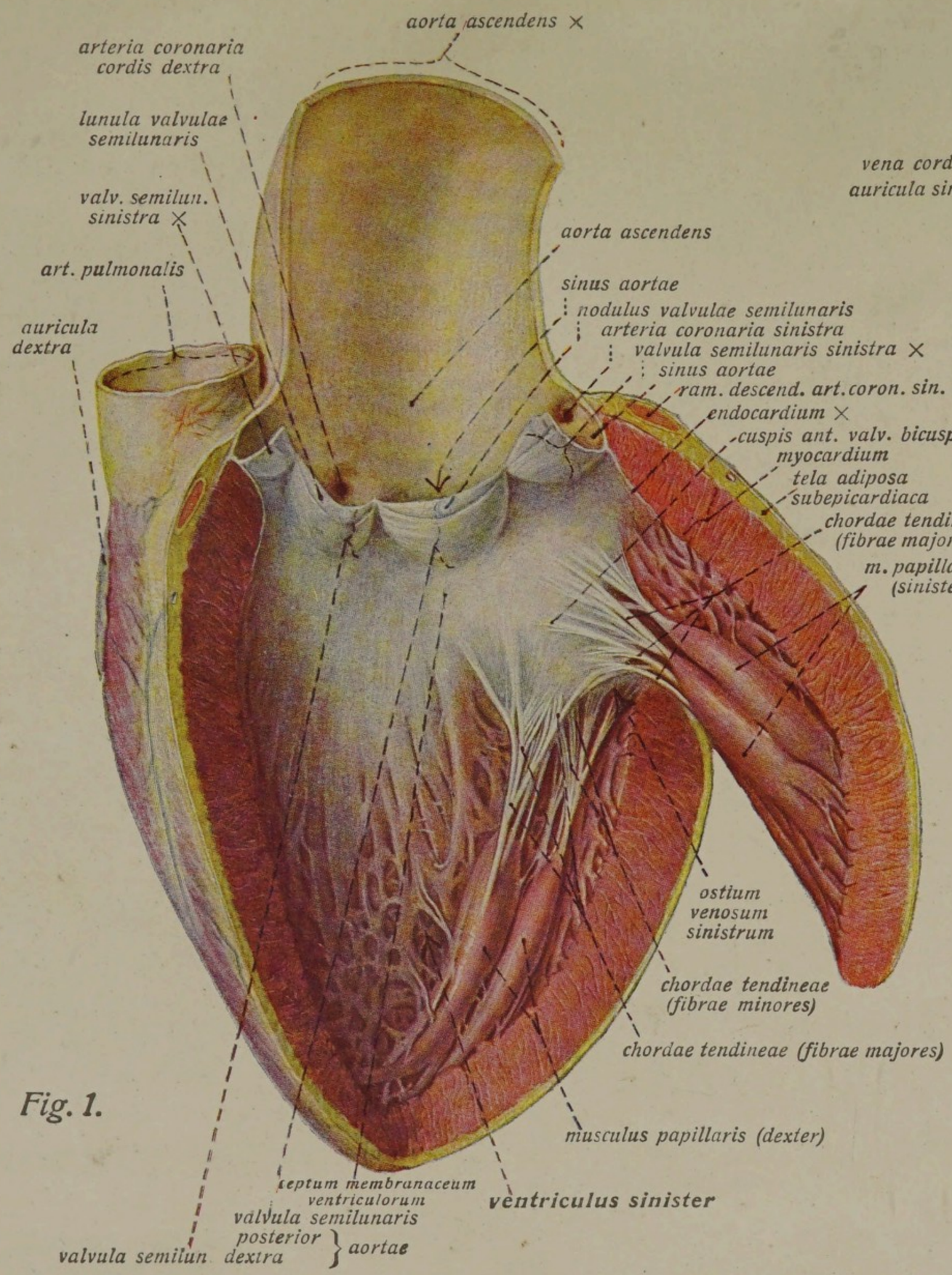


Fig. 1.

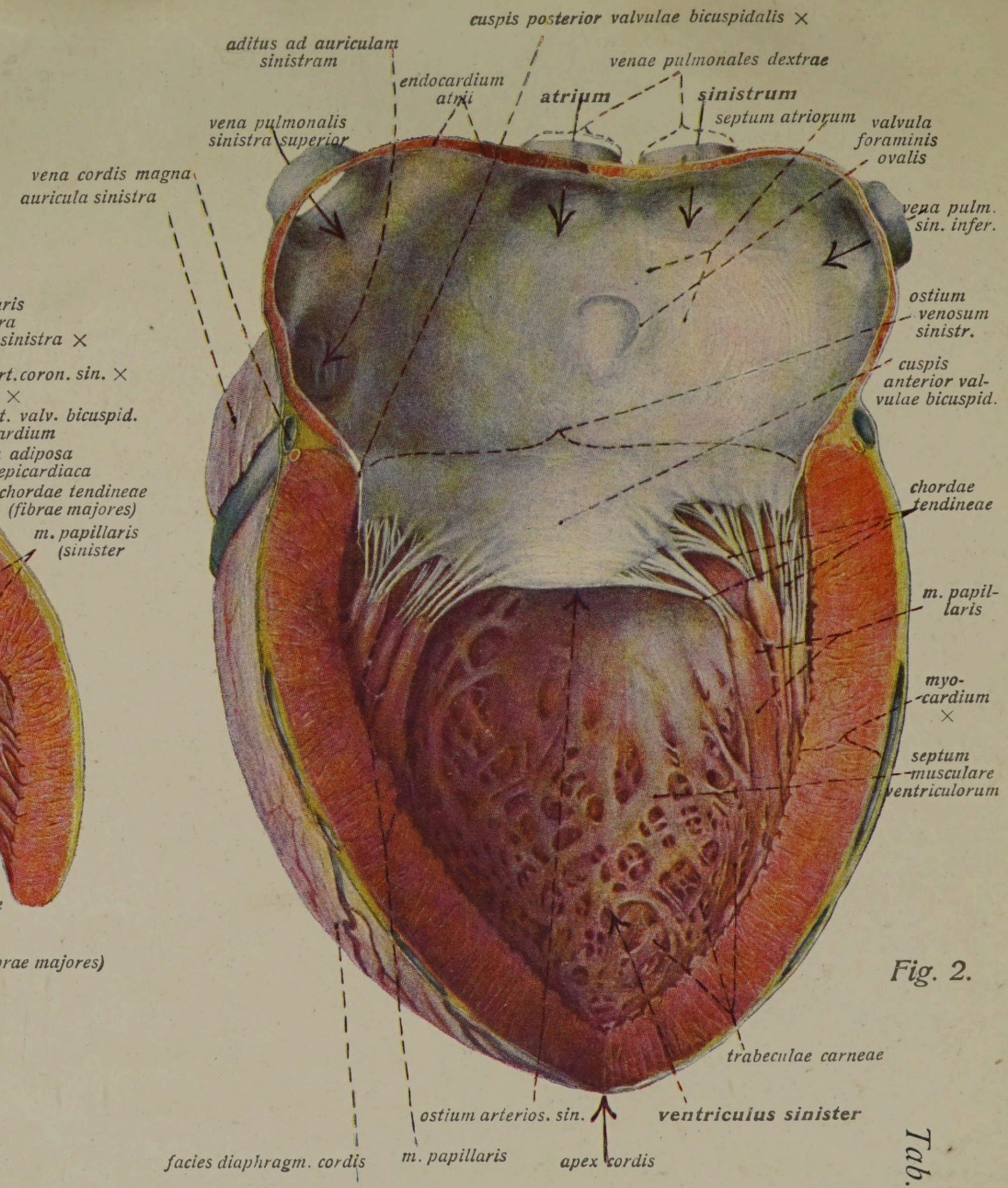


Fig. 2.

Tab. 20.

The Circulation. (Cont.) The Heart.

The systemic circulation begins in the left ventricle and passes from it by the aorta, the single large arterial vessel of the systemic circuit, from which branches pass to the various parts of the body; the blood then returns to the heart by the two great veins, the superior and inferior venae cavae, and is passed by them into the right atrium. The pulmonary circulation begins in the right ventricle, goes through the pulmonary artery and its branches to both lungs and then returns by the pulmonary veins into the left atrium. The blood, then, takes the following course; it streams from the left ventricle into the aorta and all its branches, goes from these into the capillaries of all parts of the body, giving its oxygen to the tissues and becoming "venous"; it then returns by the veins to the right atrium, thence through the right atrio-ventricular opening into the right ventricle, from there out in the pulmonary arteries to the capillaries of the lungs, in which it again takes up oxygen and passes, arterialized, to the left atrium through the pulmonary veins, thence through the left atrio-ventricular opening into the left ventricle, and then begins its circulation anew.

The Heart.

The heart *(cor)* is an almost conical, thick walled, muscular sack, whose upper, broader, fixed end is termed the *base* and its lower, freely moveable end the *apex*. It has two surfaces, distinctly separated, especially in the empty organ, except that they pass into one another at the left border. One of these surfaces is convex forwards and looks somewhat upwards; it lies behind the body of the sternum and the adjacent left costal cartilages and hence is termed the *sterno-costal surface*. The other surface looks backwards and downwards and is termed the *diaphragmatic surface*, since it rests on the diaphragm, principally upon its centrum tendineum. This surface is also convex, but a little less so than the *sterno-costal*.

Above the base of the heart lie the atria and the two arteries that arise from the ventricles; below it are the ventricles. It is indicated externally by a circular groove, interrupted in front, the *coronary sulcus*, in which lie the main stems of the vessels that nourish the heart. It lies nearer to the upper end of the heart than to the apex and contains four openings, two arterial and two venous. Two longitudinal grooves, the *anterior* and *posterior longitudinal sulci (interventricular grooves)*, indicate on the anterior and posterior surfaces of the heart the separation lines between the two ventricles, and also contain the stems of the arteries that nourish the heart (see below). The two longitudinal sulci unite to the right near the apex of the heart in a notch *(incisura apicis)*, which is not always distinct.

The Heart. (Cont.)

The wall of the heart consists of three layers; most externally is the visceral layer of the serous pericardium, termed the *epicardium*, beneath which there are, at least in adult hearts, extensive deposits of fat, especially in the sulci and in the neighborhood of the apex. Where the fat tissue is wanting the epicardium rests on the second or middle layer, the *myocardium*. This is the actual heart musculature and forms by far the thickest layer of the heart wall; in the ventricle it is more than $^{7}/_{10}$ of its thickness. The elements of the musculature arrange themselves in a highly complicated manner into bundles and layers; here only the essential features of the arrangement can be described. One of the most notable characteristics is that the musculature of the ventricles and atria are completely independent one of the other; the ventricles have their own musculature, and so also the atria. An exception to this rule is found only in a single special muscle band, the so-called conducting system or atrio-ventricular bundle, which stands in connection with the innervation of the heart and extends without interruption from the atrial musculature to that of the ventricles (see p. 433).

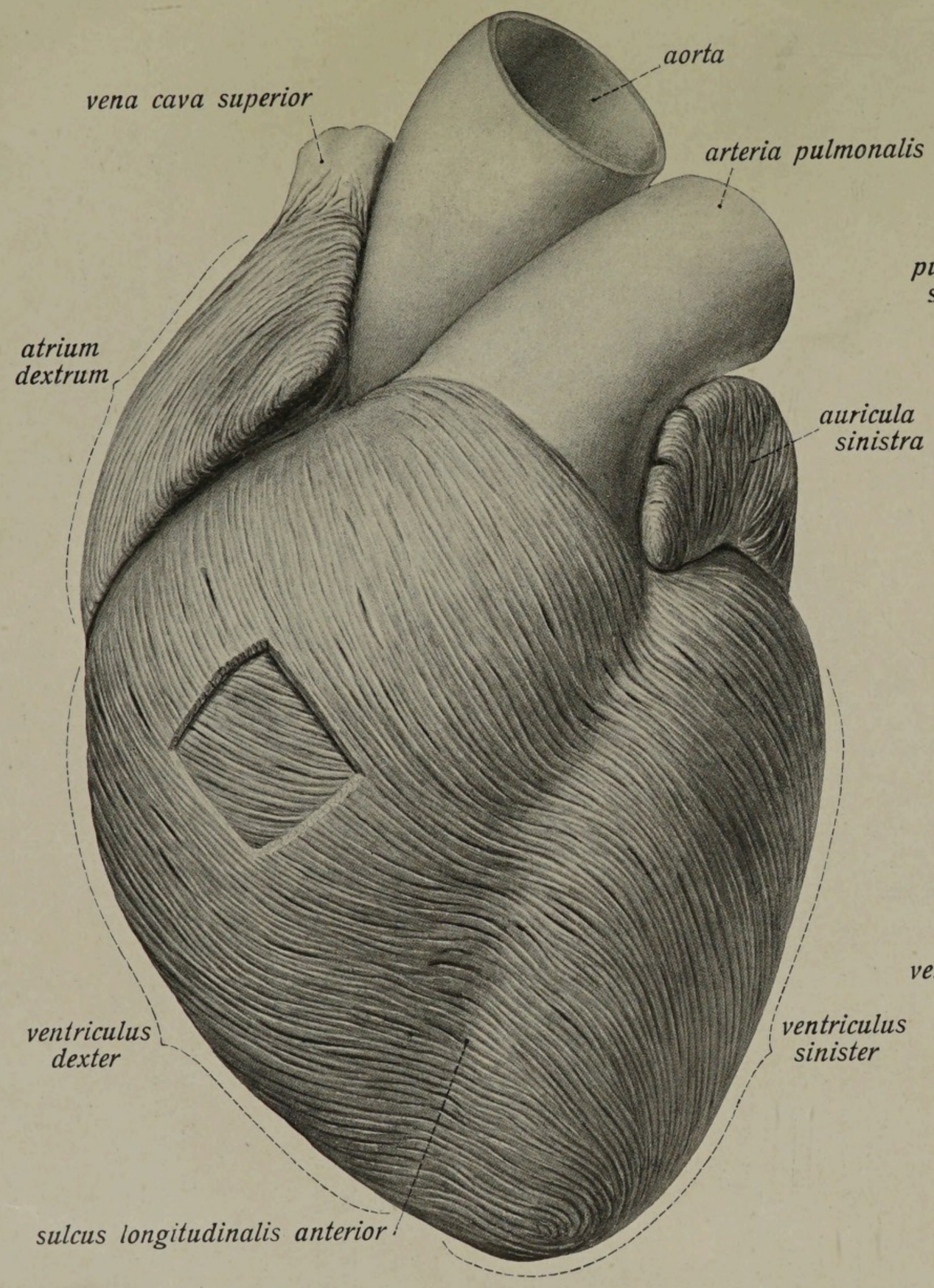
The greater portion of the musculature of the atria, as well as that of the ventricles takes its origin from connective tissue fibre-bundles which are arranged in rings around the atrio-ventricular openings. These fibrous rings take their origin from two firm cartilaginous plates one on each side of the root of the aorta; on section these are rounded-triangular and are therefore termed fibrous *trigones (right* and *left)*. The fibre-bundles that pass out from them and surround the atrio-ventricular openings are termed the *fibrous rings (right* and *left);* the right ring, which is elliptical in form, surrounds unbrokenly the right atrio-ventricular opening, the left one, on the contrary, is incomplete between the two fibrous trigones, the adjacent root of the aorta filling in the gap. The fibrous rings separate the musculatures of the ventricles and atria, since both arise from them, and at the same time they serve for the attachment of the atrio-ventricular valves.

The musculature of the *atria* consists essentially of two layers, a superficial and a deep; the former is common to both atria, the latter forms an independent layer for each atrium. The common superficial layer is not present throughout all the extent of the atria, but is represented essentially by fibres that occur chiefly on the posterior surface of the heart, where they pass from the vicinity of one auricular appendix to that of the other and are consequently termed the *horizontal interauricular fasciculus*. In addition there are also superficial vertical muscle bundles on the atria. The layer is weakest on the auricles, which are otherwise rather rich in muscles.

Fig. 532. The musculature of the heart from in front. ($^{1}/_{1}$) In the wall of the right ventricle a portion of the superficial layer is removed to expose the middle layer.

Fig. 533. The musculature of the heart from behind. ($^{1}/_{1}$) In the wall of the left ventricle a portion of the superficial layer is removed to expose the middle layer.

Fig. 533. The musculature of the heart from behind. ($^1/_1$) In the wall of the left ventricle a portion of the superficial layer is removed to expose the middle layer.



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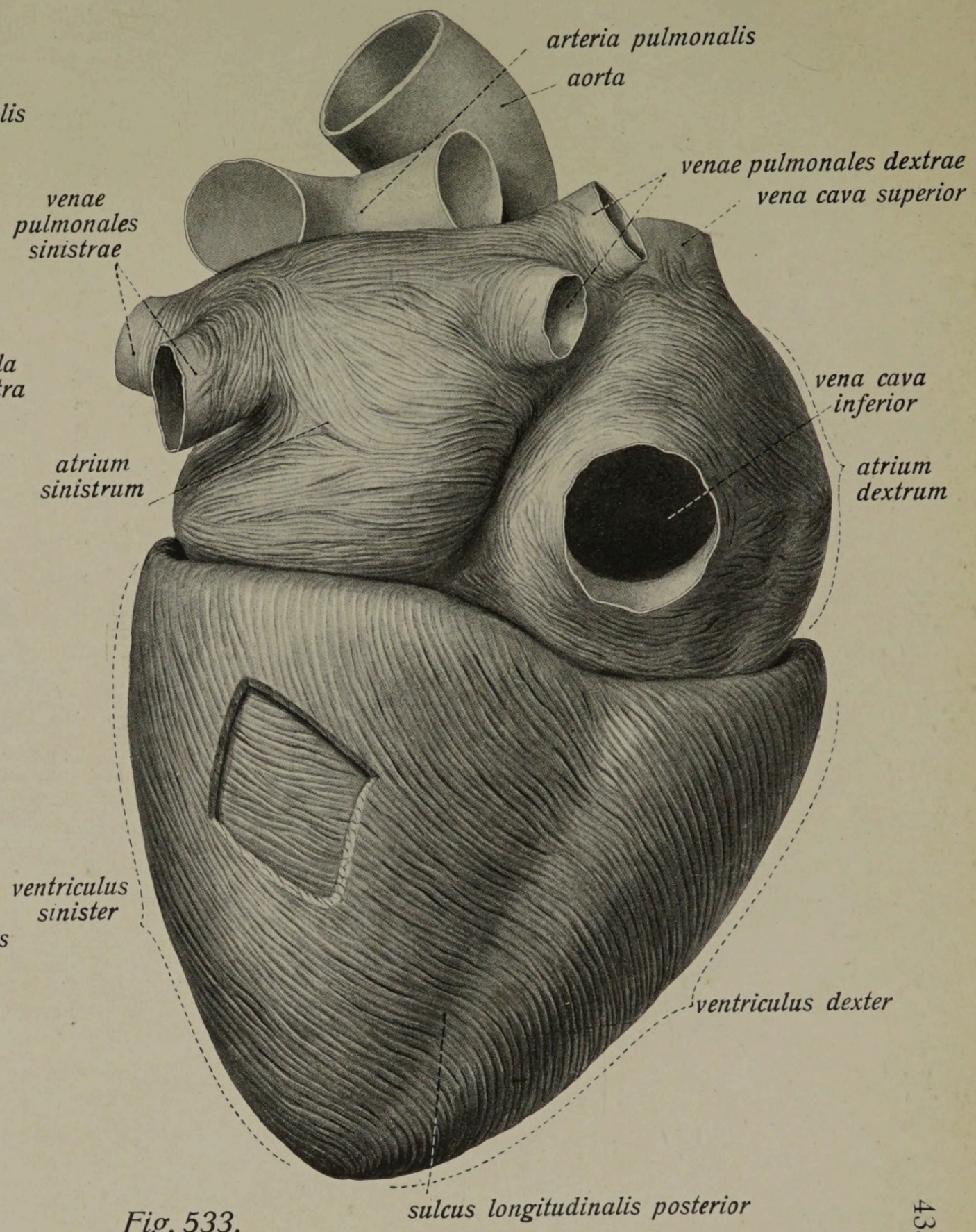

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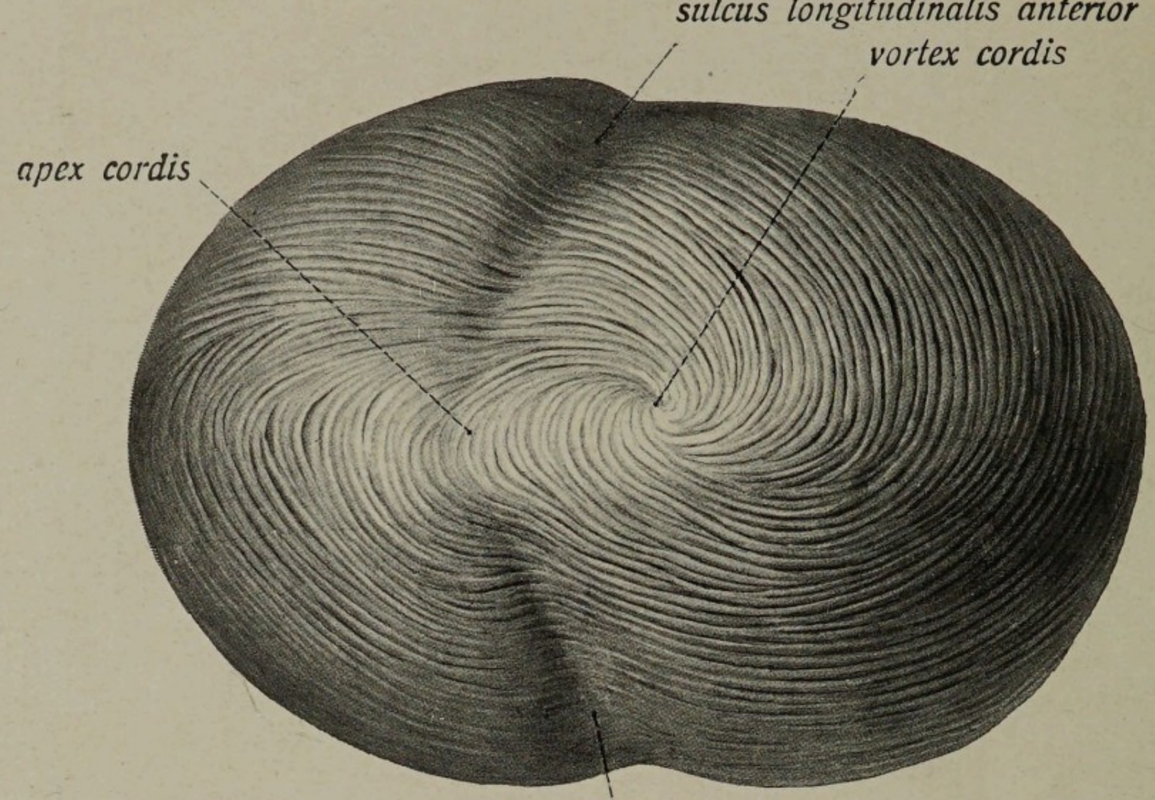

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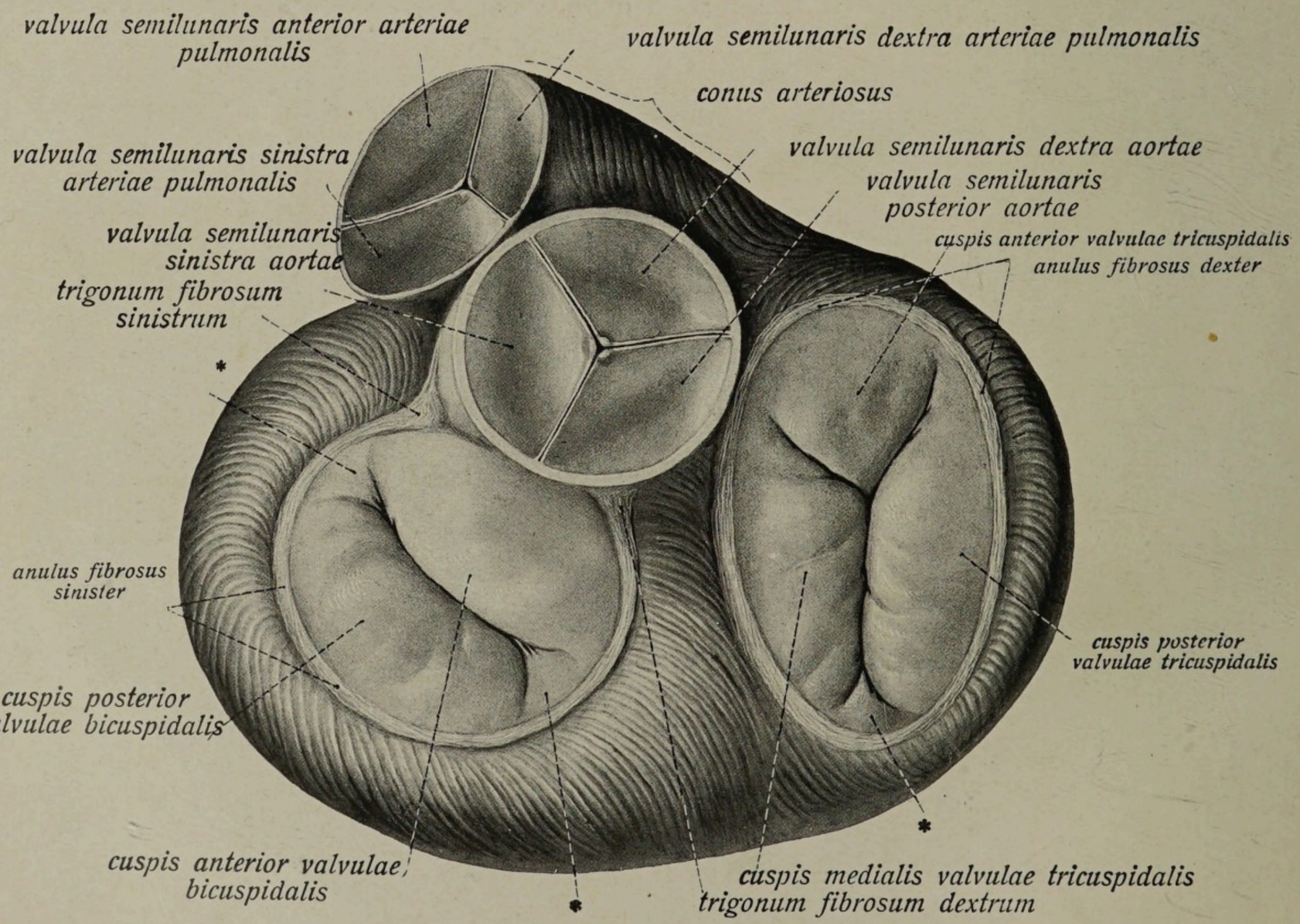


Fig. 535.

The Heart. (Cont.)

Fig. 534. The superficial musculature of the heart seen from the apex. ($^1/_1$)
Fig. 535. The four openings of the base of the heart seen from above, after removal of the atria and preparation of the superficial musculature. The valves are shown in the closed position. ($^1/_1$) * = intermediate cusp.

The *musculature of the ventricles* is arranged like that of the atria in so far as in these also there is a superficial layer common to both chambers and a distinctly stronger layer, peculiar to each ventricle. The superficial fibres cross the deep ones almost at right angles; both layers, however, are by no means sharply separated, there being frequent passages of fibres from one to the other. The superficial layer is a completely closed sheet, only a few millimeters in thickness, the fibres on the posterior surface of the ventricle having a more vertical direction than those on the anterior surface; the posterior fibres run obliquely downwards and to the right, the anterior downwards and to the left. Both converge towards the apex of the heart where they disappear, passing deeply and forming what is termed the *vortex*. They pass to the inner surface of the left ventricle, where they form in part the musculature of the ventricular septum and in part pass to the trabeculae (columnae) carneae (see below) and the papillary muscles.

The *deep fibres of the right ventricle* arise from the posterior part of the left fibrous ring, in the angle between the two rings, and from the posterior and right portions of the right ring. They are less vertical than the superficial fibres that cover them, being almost horizontal near the base of the heart. They form the main mass of the wall of the right ventricle, in which they have a rather complicated arrangement.

The *deep fibres of the left ventricle* form by far the strongest muscle mass of the entire heart. They arise from the anterior portion of the left fibrous ring, especially from the left fibrous trigone and partly also from the adjacent part of the right fibrous ring. Their course is not so steep as that of the superficial fibres. The muscle bundles pass from the anterior surface of the ventricle over its rounder border to the posterior surface, where they bend into the ventricular septum, some, however, passing to the anterior papillary muscle. Another group of bundles runs on the inner surface of those just described back over the rounded border of the heart to the posterior surface of the ventricle and terminate partly on the right fibrous trigone and partly in the posterior papillary muscle.

The only muscle bundle of the heart that is common to the atria and ventricles is the so-called *conducting-system* or *atrio-ventricular bundle.* Its starting point is the so-called Tawara node *(atrio-ventricular nodule)* an elongated oval thickening of the musculature of the atrial septum, measuring 0,6 mm in its long diameter. It lies on the right surface of the right fibrous trigone, so that the right branch of the bundle passing to the right ventricle, lies in the same plane as the common stem, while the left branch bends to the left after gradually separating from the common stem. The right branch is a circumscribed, almost circular, small muscle bundle, that runs in the musculature of the ventricular septum, near its surface and at times close under the endocardium. The left branch also lies in the ventricular septum, but much more superficially than the right, lying directly under the endocardium, so that it is visible in part through this. From its point of separation from the common stem the left branch runs towards the apex of the heart, bending forward in a low curve and, after a usually short course between the posterior semilunar valve of the aorta and the upper border of the fleshy part of the ventricular septum, it divides into an anterior and a posterior bundle. The former runs beneath the endocardium to the trabeculae (columnae) carneae (see below) lying to the medial side of the anterior papillary muscle and passes into the base of that muscle. The posterior bundle continues the course of the common stem, also beneath the endocardium, and passes to the base of the posterior papillary muscle.

The Heart. (Cont.)

The atrio-ventricular valves are duplicatures of the endocardium, fastened by their bases to the fibrous rings of the atrio-ventricular openings. They are divided by more or less deep incisions into lobes or cusps, of which that of the left opening has two *(bicuspid valve)*, that of the right three *(tricuspid valve)*. Weaker incisions may produce an incomplete division of the individual cusps. The thread-like tendons of the papillary muscles, the *chordae tendineae*, are attached to the edges and under surfaces of the cusps. When open the cusps hang loosely in the cavity of the ventricle, resting on its wall; when closed the free edges of the cusps come together, forming a shallow, funnel-shaped groove on the atrial surface.

The right atrium is a somewhat conical cavity whose slightly curved apex is formed by the *right auricle* (auricular appendix). It includes the actual atrium and the venous sinus *(sinus of the venae cavae)*, which is separated from the atrium proper by a muscle ridge, the *terminal crest*, corresponding to a groove on the outer surface. The sinus receives from above the superior vena cava and from below the stronger inferior vena cava, the openings of these being opposite one another and separated by a prominence of the atrial wall, the *intervenous tubercle* (Lower's). At the opening of the inferior vena cava there is a semilunar valve, often broken through in the adult, the *valve of the inferior vena cava* (Eustachian), which is placed between the opening of the vein and the right atrio-ventricular opening. In addition, the veins of the heart wall open into the right atrium by the *coronary sinus*, whose opening is between the valve of the inferior vena cava and the right atrio-ventricular opening. Here also there is a thin semilunar valve, the *valvula of the coronary sinus* (Thebesian). The minute openings of the numerous smaller veins of the heart are in the region of the atrial septum and on the right wall. The septum throughout an elongated or oval area remains destitute of muscle, forming a translucent area, the *membranous portion* of the septum. It marks the position of the *foramen ovale*, which remains open until birth and forms a slight depression on the lower part of the septum; it is surrounded, especially at its upper and anterior parts, by a well developed muscular thickening, the *limbus of the fossa ovalis* (Vieussenii).

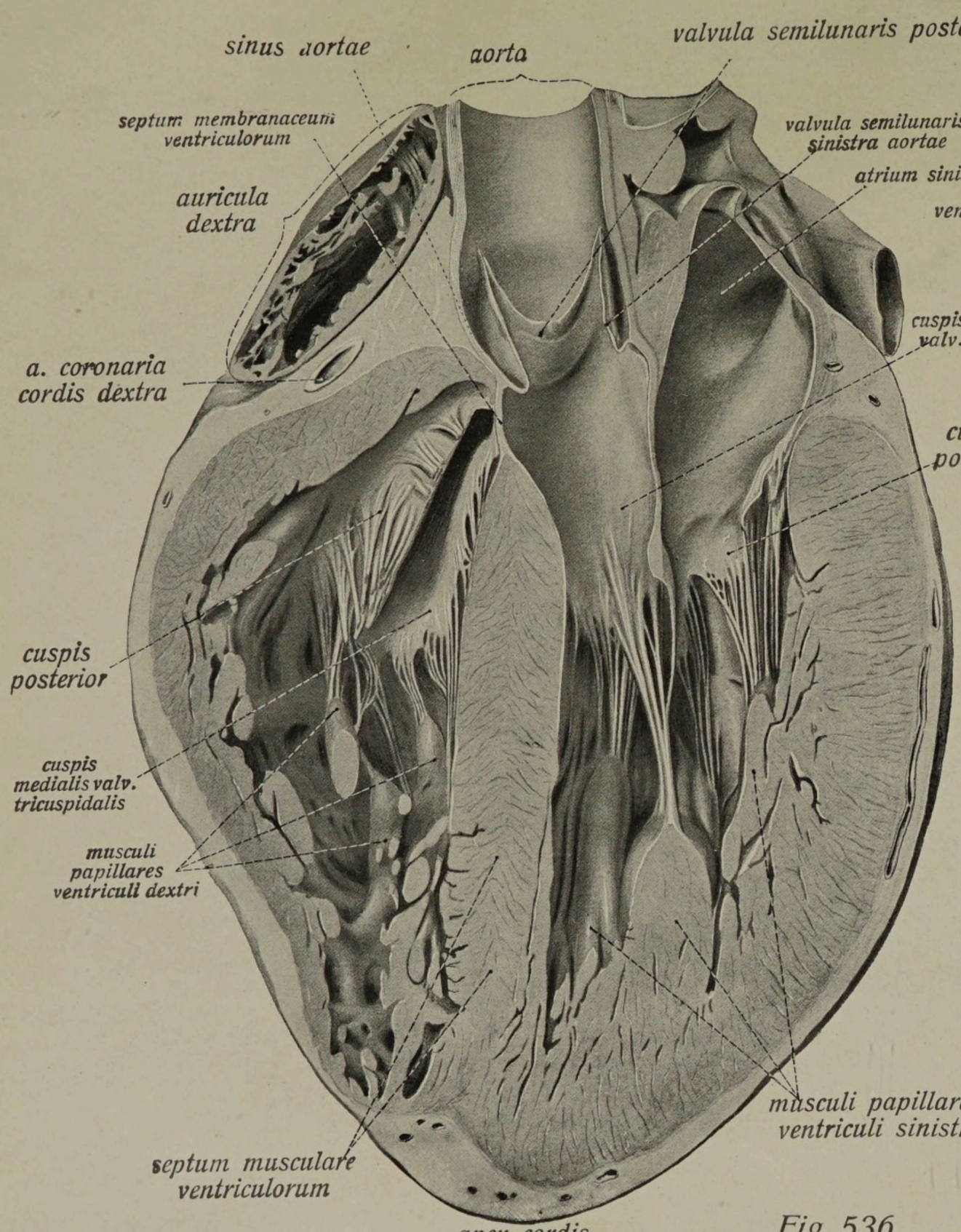
The *right ventricle* is almost conical, but since its left surface, that towards the left ventricle, is concave, its transverse section is semilunar. Its apex does not reach the apex of the heart. From the ventricle the *right atrio-ventricular opening* leads into the right atrium, the *right arterial opening* into the pulmonary artery. The former is on the base of the ventricle and has usually a three-cusped valve, the *tricuspid valve*, the smaller *anterior cusp* being anterior and somewhat to the right, while the other two larger ones are *posterior* and *medial*. The arterial opening lies in the anterior left portion of the base of the ventricle, close to the septum, and is at the summit of a conical prolongation of the ventricle, the *conus arteriosus*. This is limited by a weak muscle ridge in the interior of the ventricle, the *supra-ventricular crest*. At the arterial opening are three semilunar valves, one of which is *anterior* and others *right* and *left*.

Fig. 536. Frontal section of the heart, especially of the ventricles. View of the anterior half of the section from in front. ($^1/_1$)

Fig. 537. Frontal section of the heart, especially of the atria. View of the posterior half of the section from behind. ($^1/_1$)

behind. (1/1)

of the heart, especially of the atria. View of the posterior half of the section from



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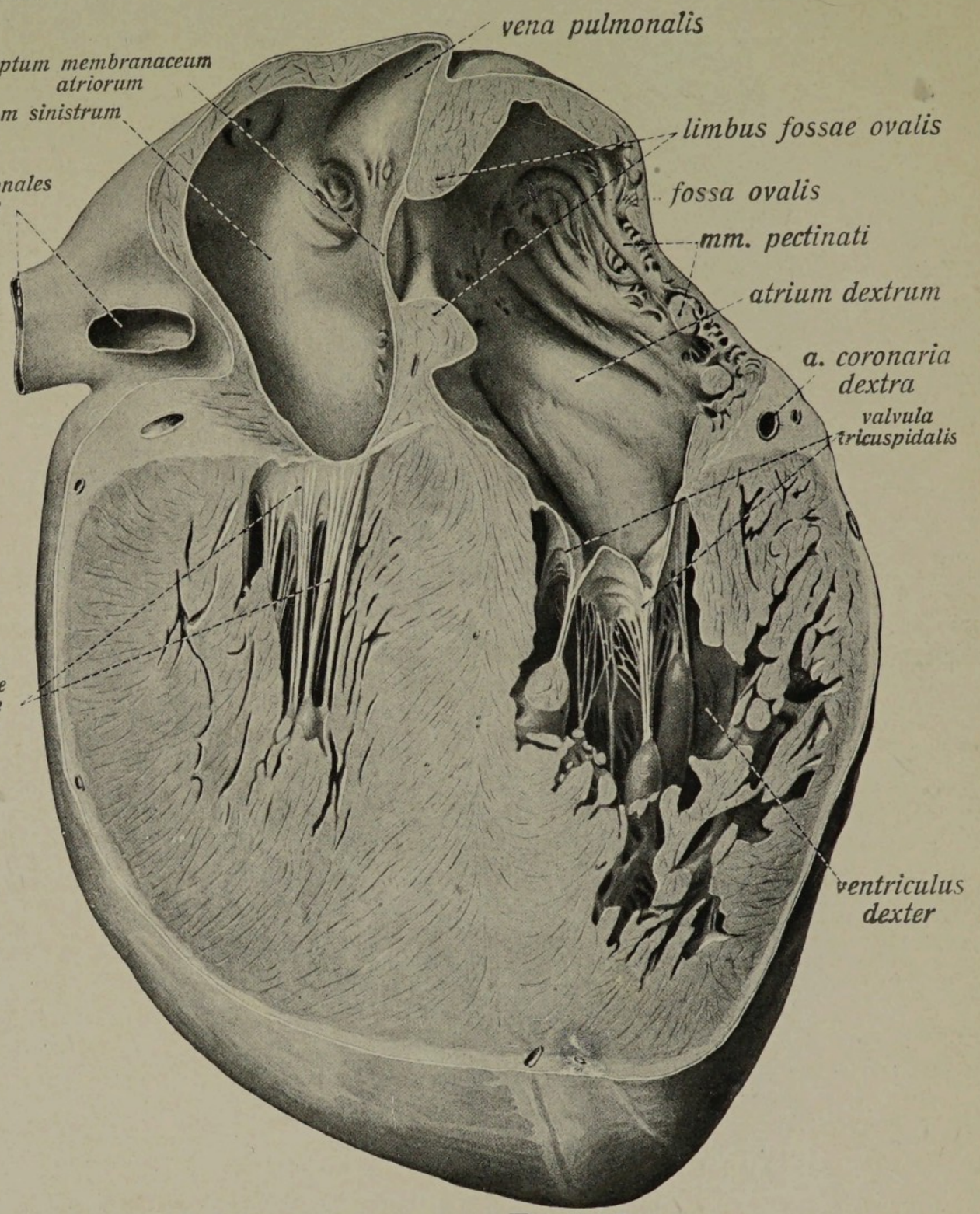

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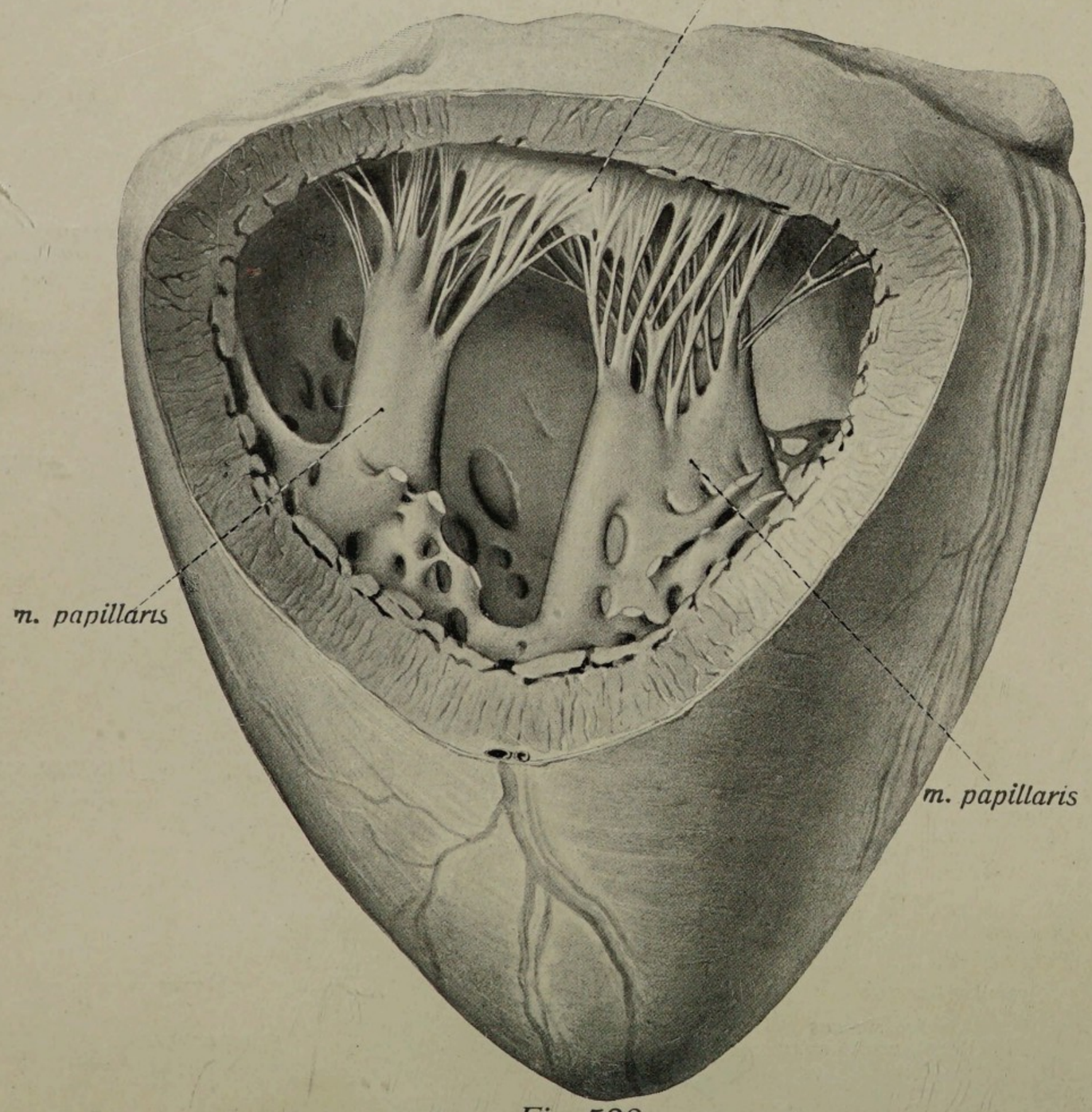

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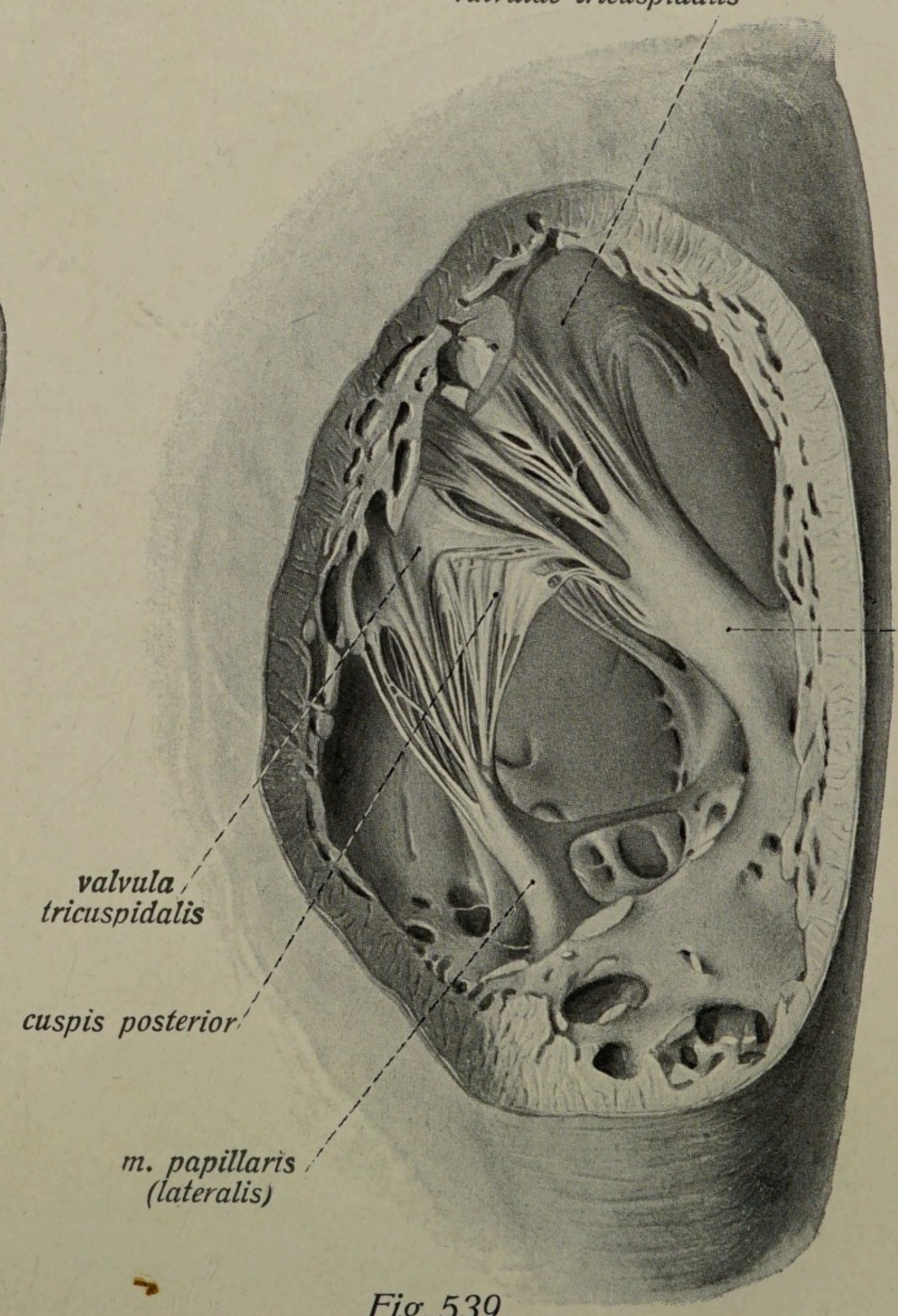


Fig. 539.

Fig. 538. The interior of the left ventricle, posterior wall. (1/1)

The Heart. (Cont.)

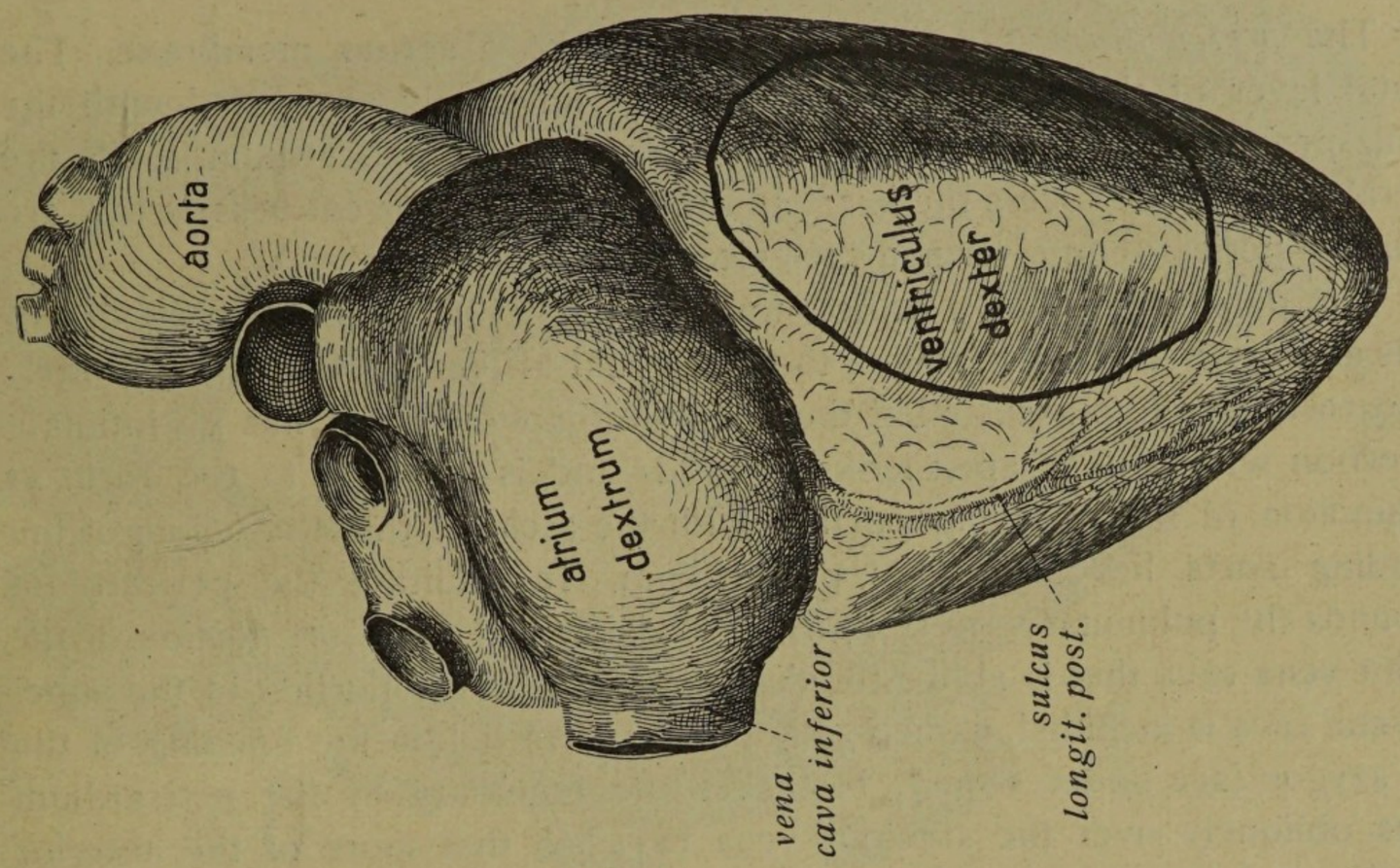


Fig. 540.

Fig. 538. The interior of the left ventricle, posterior wall. ($^1/_1$)
Fig. 539. The interior of the right ventricle. ($^1/_1$) The line of incision is shown in Fig. 540.

The *left atrium* is irregularly cubical in form and on its anterior wall the *left auricle* (auricular appendix) forms a conical appendage. The right wall is formed by the atrial septum and in the lower one there is the left atrio-ventricular opening *(ostium venosum sinistrum)*. The openings of the four *pulmonary veins* are so placed that the pair from each lung are close together, while the two pairs are some distance apart. Rarely the two veins of the same side unite to form a single vein. In contrast to what is seen in the right atrium, the wall of the septum is smooth, except for the usually inconspicuous remains of the sickle-shaped *valve of the foramen ovale.*

The *left ventricle* has the form of an oval, truncated above. Its thick walls are convex throughout, even in the region of the septum. On its base, which is directed posteriorly and to the right, the left *atrio-ventricular* and arterial openings lie close together. The former has a *bicuspid (mitral) valve* and lies to the left of and behind the latter. One cusp, the *anterior*, looks forward and to the right, the other, the *posterior*, backwards and to the left. The posterior one takes its origin from the fibrous ring, the anterior partly from this and partly from the posterior part of the root of the aorta. As a result the upper surface of the anterior cusp passes over directly into the inner surface of the aorta. Connected with the bicuspid valve are two large papillary muscles, very constant both in number and position.

The *left arterial opening*, the aortic, lies anteriorly and to the right at the base of the heart, in front of the anterior cusp of the mitral valve and behind the root of the pulmonary artery. Of its three semilunar valves, one is to the *right* and one to the *left* as in the pulmonary set, but the third is *posterior*. They possess well-developed lunulae and strong nodules. The inner lining of the heart, the endocardium, is a membrane which is thin in the ventricles and auricular appendices, but thicker elsewhere in the atria. It lines the entire cavity of the heart, including the muscular elevations on the walls of the ventricles and in the auricular appendices. The former are partly more or less elevated ridges, termed *trabeculae (columnae) carneae*, partly conical projections, the *papillary muscles*, from which the majority of the chordae tendineae (see above) pass to the atrio-ventricular valves. The muscle trabeculae of the auricular appendices are termed *pectinate muscles;* they are covered by thin endocardium, have a more regular arrangement than the trabeculae carneae of the ventricles and are of about the same height.

The Pericardium.

The *pericardium* is a fibrous sack lined by a serous membrane. The parietal layer of the serous membrane is so intimately associated with the fibrous pericardium that both are included in the term pericardium, while the visceral layer which covers the heart and the parts of the great vessels that are within the pericardium is termed the epicardium.

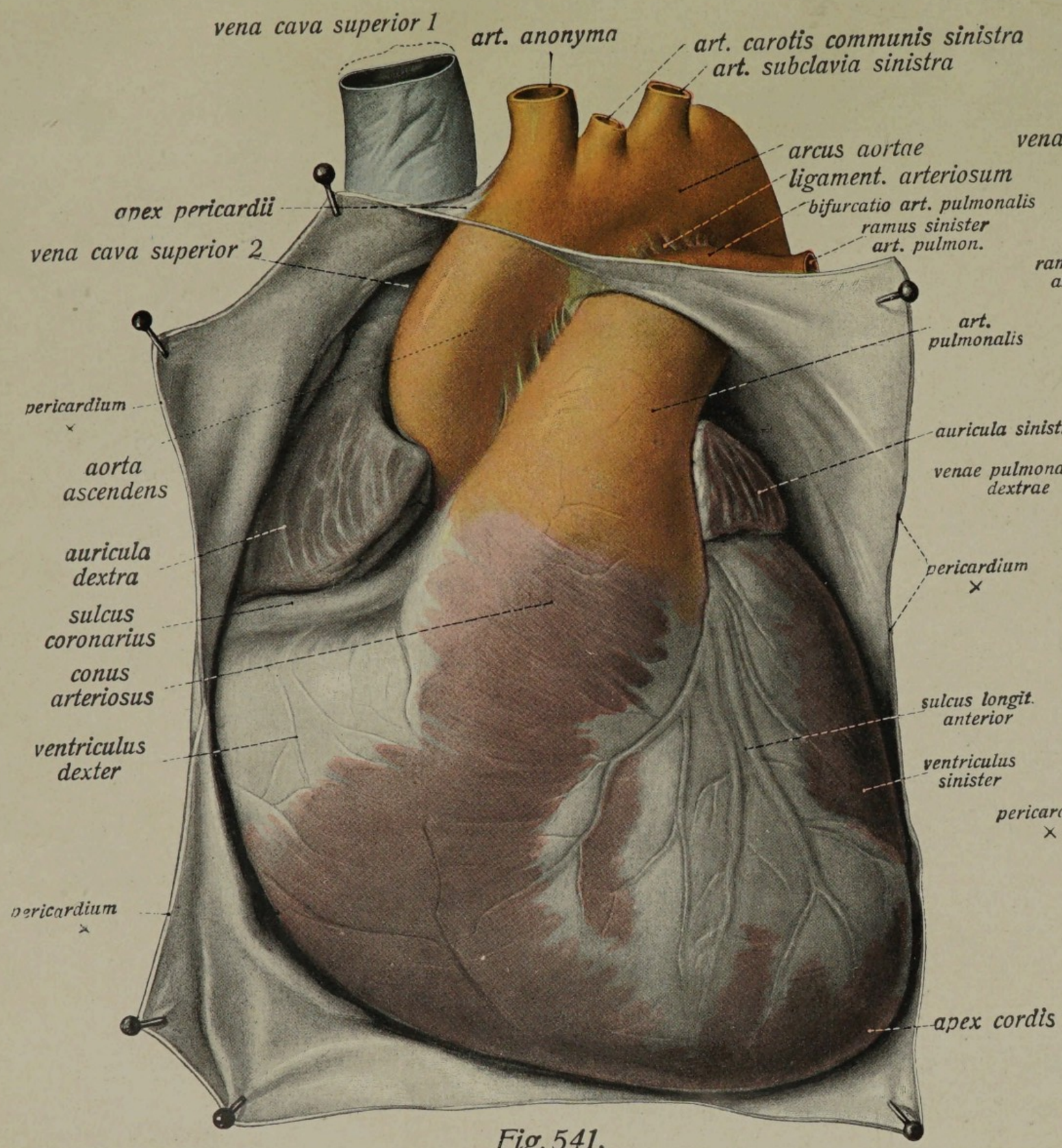
The pericardium has a conical form (see p. 443). Its base looks downwards and rests on the diaphragm, to whose central tendon it is firmly united; it also rests on the muscular left dome of the diaphragm but has no intimate connection with it. The apex looks upwards and is attached to the aorta at the junction of its ascending portion with the arch, so that the whole of the ascending aorta lies inside the pericardium. In addition the pericardium surrounds the pulmonary artery up to its division and the short portion of the inferior vena cava that is above the diaphragm. A longer portion of the superior vena cava is included, namely, all of it that lies below the opening of the vena azygos (see under Veins). However the boundary of the pericardium passes obliquely over the superior vena cava, so that more of the anterior than the posterior surface of the vein is covered by epicardium. The left pulmonary veins have only a short course within the pericardium, the right veins a longer one. The ligamentum arteriosum (Botalli) lies outside the pericardium, but produces an elevation upon its inner surface.

At the passage through the pericardium of the great vessels the fibrous layer of the membrane fuses with their walls, while the serous layer is reflected over the vessels as the visceral layer or epicardium. This reflexion of the parietal into the visceral layer takes place only at two regions and not at each of the eight vessels that pass through the pericardium. The two arterial trunks, which are united by connective tissue, have a common epicardial sheath and, in a similar manner, the parietal layer is reflected as epicardium upon the posterior wall of the atrium and the venous stems connected with it. Thus there is formed a transverse space, bounded in front by the arterial trunks and behind by the left pulmonary veins and the vena cava superior. This is the *transverse sinus* of the pericardium. In the adult it will give passage to 2 (—3) fingers. Between the atria and the terminations of the various veins, for instance between the left atrium and the left pulmonary veins, there are pockets which are sometimes deep, but blind, that between the inferior vena cava and the lower left pulmonary vein (the so-called oblique sinus) being the deepest.

Fig. 541. The heart in the pericardium, from in front. The pericardium is opened from in front. ($^4/_5$)
1 and 2 after vena cava superior indicate the portions outside and within the pericardium.

Fig. 542. The sinus transversus of the pericardium seen from the right side. ($^4/_5$)
The aorta and superior vena cava are drawn apart.

Fig. 542. The sinus transversus of the pericardium seen from the right side. (4/5)
The aorta and superior vena cava are drawn apart.



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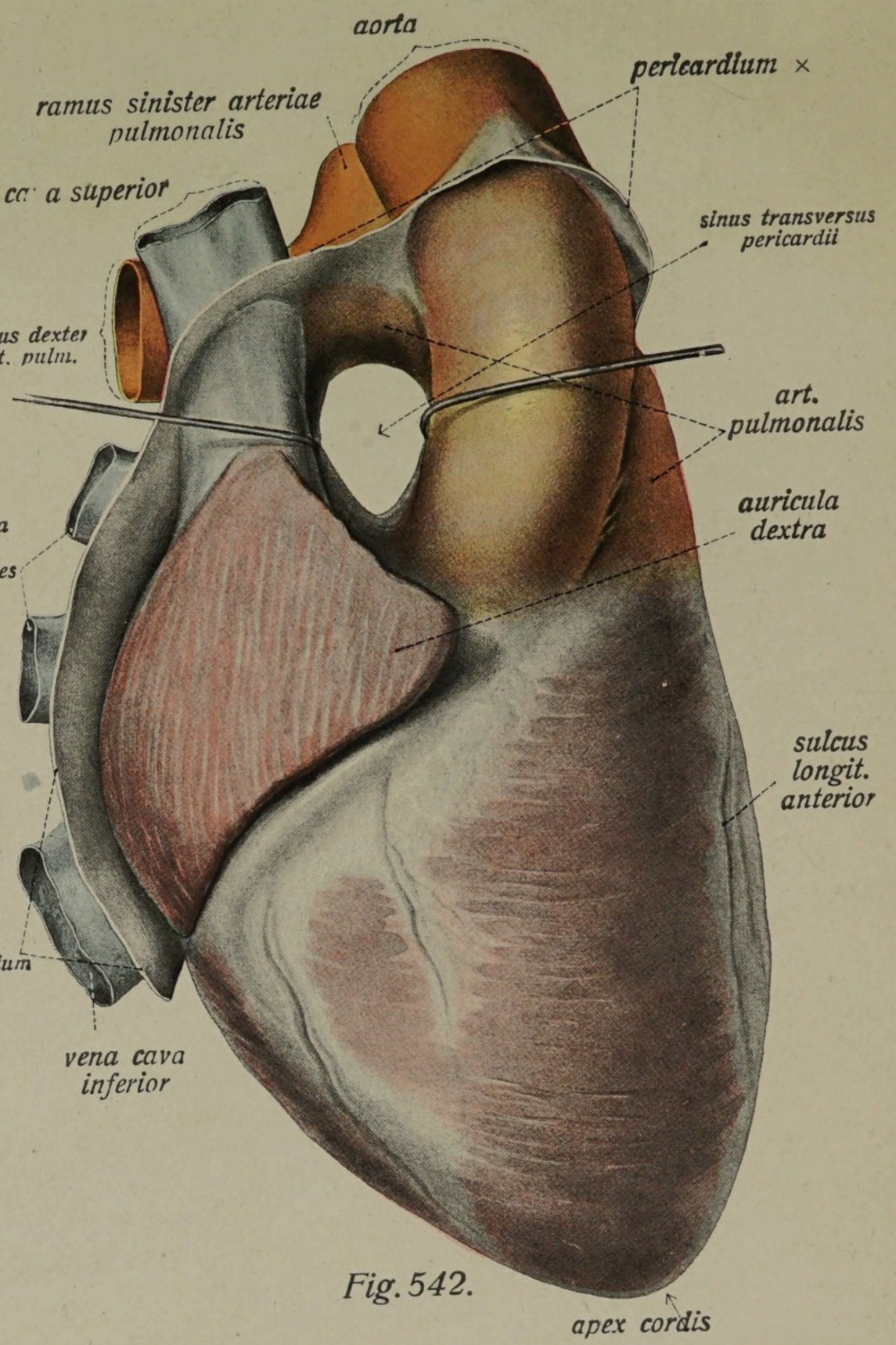

Fig. 542.

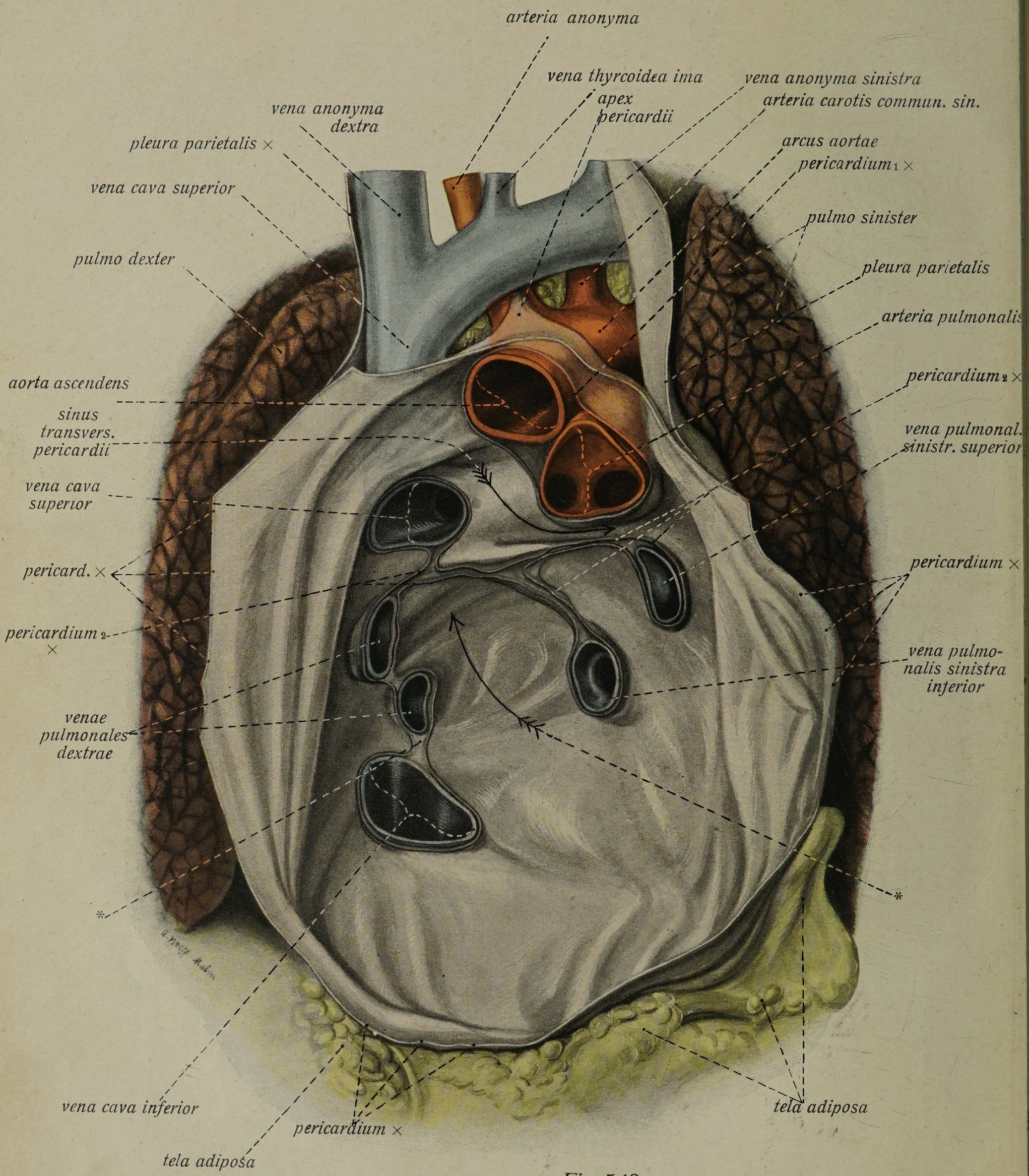
arteria anonyma
vena thyrcoidea ima
vena anonyma sinistra
apex pericardii
arteria carotis commun. sin.
vena anonyma dextra
pleura parietalis ×
arcus aortae
pericardium 1 ×
vena cava superior
pulmo sinister
pulmo dexter
pleura parietalis
arteria pulmonalis
aorta ascendens
pericardium 2 ×
sinus transvers. pericardii
vena pulmonal. sinistr. superior
vena cava superior
pericard. ×
pericardium ×
pericardium 2 ×
vena pulmonalis sinistra inferior
venae pulmonales dextrae
vena cava inferior
pericardium ×
tela adiposa
tela adiposa

Fig. 543.

The Pericardium. (Cont.)

Fig. 543. Anterior view of the pericardium opened from in front, after removal of the heart. ($^1/_1$)

The pericardium has been divided from above downwards and the cut edges drawn apart. The eight vessels that arise from or enter the heart and penetrate the pericardium are cut so as to allow the removal of the heart. In this preparation there happens to be an especially deep pocket between the two left pulmonary veins.

* = Connection of the place of reflexion of the pericardium upon the vena cava inferior.

The manner in which the parietal and visceral layers of the pericardium are reflected is as follows: The arterial reflexion has already been described, both arterial trunks being included in a common epicardial sheath, which bounds the transverse sinus anteriorly. More complicated is the reflexion upon the six venous trunks; to begin with the superior vena cava, which lies to the right of the transverse sinus, the line of reflexion passes from it at first transversely, forming the lower boundary of the transverse sinus, to the superior left pulmonary vein; there follows then an acute angled pocket, open to the left, at whose lower boundary the reflexion upon the inferior left pulmonary vein occurs; from here the line of reflexion, bounding the large pocket between the inferior vena cava and the inferior left pulmonary vein (see above), passes back parallel to the lower boundary of the transverse sinus to where the superior vena cava pierces the pericardium; it then runs almost vertically downwards, in this part of its course surrounding first both right pulmonary veins and then the inferior vena cava.

The form of the pericardium is that of a scalene triangle. From the base, adherent to the diaphragm, the small right side passes almost vertically upwards to the apex, while the longer, left side runs obliquely. The anterior surface of the pericardium lies behind the sternum and the costal cartilages and is fastened to these partly by loose connective tissue and partly by stronger bundles, the *sterno-pericardial ligaments*. A considerable portion of the anterior surface of the pericardium is covered by the thymus in the child; in the adult occasionally a much smaller portion is covered by the remains of the gland. The lateral surfaces of the pericardium are covered by the pericardial pleurae united to them by epi-pericardial connective tissue, which is often fatty.

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